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ARTICLES

TOXICITY OF CERTAIN OIL EMULSIONS TO MOSQUITO LARVAE AND PUPAE

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During 1940–42 the writer conducted special investigations in Oregon to increase the efficacy of oils against mosquito larvae and pupae through the use of emulsifying agents or spreaders, or both. The investigations demonstrated that certain emulsifiers greatly increased the efficacy of a given amount of oil against larvae and pupae. Results of field tests and suggestions for the use of certain formulations in mosquito control were published in 1943.[1] About this time the use of DDT for controlling mosquito larvae was developed. The performance of this and other available mosquito larvicides was so vastly superior that there seemed to be little need for a practical consideration of oils alone.

In recent years, however, strains of mosquitoes that have developed a marked resistance to DDT have appeared in certain parts of the United States. Experience with similar resistance in the house fly indicates that this problem may become more general and widespread. It may be necessary, therefore, to resort to oils for controlling mosquito larvae where the resistance problem is acute.

The control of mosquito pupae with DDT has always been unsatisfactory. The application of oil emulsions containing special emulsifying and spreading agents may therefore be advantageous for controlling mosquito pupae, because pupae are inherently quite resistant to insecticides such as the chlorinated hydrocarbons.

This paper presents data obtained with some of these emulsions in the field as well as in the laboratory. Since the efficacy of oils against larvae, and particularly against pupae, was increased, the information given here may stimulate other workers to investigate emulsifying agents as a means for improving the control of mosquito larvae and pupae.[2] Further studies along this line are now under way at the Bureau's Corvallis, Oregon, laboratory.

LABORATORY TESTS

In the laboratory tests enameled pans about 11 inches in diameter and 4½ inches deep with sloping sides were used. Into each pan was placed 3 liters of water. The water was about 2½ inches deep and had a surface area of 80 square inches. No. 2 fuel oil or diesel oil obtained locally was used. Emulsions of the oils were added to the water in desired amounts with a pipette. Various oil emulsifiers were used in comparison with coconut oil soap, which was the standard emulsifier for the New Jersey pyrethrum larvicide. A stock emulsion (without the addition of pyrethrum) was prepared by mixing 2 parts of oil and 1 part of water containing 6 percent of coconut oil soap, and was diluted with water as desired. The same preparation with pyrethrum added was also used in some tests. Although this pyrethrum emulsion had been used successfully in New Jersey and other states in

[1] E. F. Knipling, C. M. Gjullin, and W. W. Yates. A New Oil-Emulsion Mosquito Larvicide. U. S. Bur. Ent. and Plant Quar. E-587, issued April 1943.

[2] D. M. Jobbins, of the New Jersey Agricultural Experiment Station, encouraged the writer to publish some of the data obtained.

the East, its performance in Oregon was erratic and generally undependable.

Larvae and pupae of *Aedes vexans* Meigen and *A. sticticus* Meigen were used in most of the laboratory tests. The eggs were collected in soil and debris along the Columbia River, and the larvae and pupae were reared in the laboratory. In most cases the ratio of *A. vexans* to *A. sticticus* was approximately 3:1. The two species were about equally susceptible to insecticides. Some tests were also made with other species of mosquitoes.

Most of the emulsifiers selected for comparison with coconut oil soap were oil-soluble. Three percent of the emulsifier was added to the oil before it was diluted with water.

All applications were calculated on the basis of a given amount of oil per acre of water surface. Usually 25 fourth-instar larvae or 10 to 25 pupae were used in each test. Mortality records were taken after 24 and 48 hours, but results are given for the 24-hour period only as they are considered more valid. Moribund larvae were included in calculating mortality. A larva was considered moribund when it could not remain on the surface. Experience indicated that larvae in such condition following exposure to oils would soon die.

The results with some of these tests are presented in Tables 1, 2, and 3.

Table 1 shows that an emulsion made with Nopco 1216 [3] required less than half as much oil to kill *A. vexans* larvae as an emulsion made with coconut oil soap. Furthermore, a given amount of oil emulsified with the Nopco emulsifier proved equally as toxic as oil containing pyrethrum and emulsified with coconut oil soap. The emulsifier B-1956 [4] was only slightly less effective than Nopco 1216. Several other emulsifiers tested at about the same time showed only slight or no advantage over coconut oil soap.

Table 2 shows additional data obtained with Nopco 1216 and also the results with

TABLE 1.—Toxicity of fuel oil emulsified with coconut oil soap, Nopco 1216, and B-1956 to fourth-instar larvae of *Aedes vexans* and *A. sticticus*. Laboratory tests.

Oil Concentrate (figures in percent)	Dilution	(gallons per acre) Emulsion	Oil	Number of tests	Percent mortality after 24 hours
Oil 66.7, water 31.3, and coconut oil soap 2.0	1:4	10	1.3	5	22
		15	2.0	5	66
		20	2.6	5	90
Same as above with pyrethrins 0.07 (New Jersey larvicide)	1:9	5	.33	6	34
		7.5	.5	10	56
		10	.67	11	68
		15	1.0	7	87
		20	1.3	1	100
Oil 97 and Nopco 1216 3	1:6.5	5	.67	11	57
		7.5	1.0	7	92
		10	1.3	8	99
		15	2.0	7	99
		20	2.6	4	100
Oil 97 and B-1956 3	1:6.5	10	1.3	3	92
		15	2.0	3	100
		20	2.6	3	100

[3] A sulfated sperm oil produced by the Nopco Chemical Company.

[4] A phthalic glyceryl alkyl resin produced by Rohm and Haas Company.

TABLE 2.—Toxicity of diesel oil emulsified with Nopco 1216 and Amine 230 X to fourth-instar larvae of different species of mosquitoes.

Species	Emulsified with Nopco 1216			Emulsified with Amine 230 X		
	Gallons of oil per acre	Number of tests	Mortality after 24 hours	Gallons of oil per acre	Number of tests	Mortality after 24 hours
Aedes vexans	0.5	4	52	0.5	4	34
A. sticticus	.75	5	85	.75	3	81
	1.0	5	91	1.0	5	94
	1.5	1	100	1.5	1	100
A. cinereus	0.5	3	99	0.5	3	82
	1.0	3	100	1.0	2	100
	1.5	2	100	1.5	1	100
A. hexadontus	1.0	2	100	...	..	..
	1.5	1	100	...	..	..
C. pipiens [1]	1.0	6	61	1.0	6	74
	1.5	6	79	1.5	6	97

[1] Diesel oil emulsified with coconut oil soap in one test at 2 gallons of oil per acre caused 68% mortality.

another promising emulsifier called Amine 230 X.[5] Data in this table show the effectiveness of the emulsifiers used with diesel oil against several species of mosquitoes. Amine 230 X in general proved equally as effective as Nopco 1216. Larvae of *A. cinereus* Meigen and *A. hexadontus* Dyar were found to be at least as susceptible as *A. vexans* to the emulsified oils. *Culex pipiens* L. was indicated to be more resistant than the *Aedes* species, although a rather high mortality was obtained with relatively small amounts of emulsified oil.

Table 3 shows the relative effectiveness of fuel oil to *A. vexans* and *A. sticticus* pupae when emulsified with Nopco 1216 and coconut oil soap. Data are also given for certain quantities of oil containing pyrethrins applied in the form of the New Jersey larvicide. The fuel oil alone emulsified with Nopco 1216 was far more effective than the coconut oil soap emulsions with or without the pyrethrins. With Nopco 1216 only one-sixth to one-eighth the amount of fuel oil was required to produce a given mortality as when coconut oil soap was used. Oil alone emulsified with Nopco 1216 was two to three times as effective as the oil containing pyrethrum emulsified with coconut oil soap.

Tests were also run to compare the efficacy against pupae of oils emulsified with Nopco 1216 and Amine 230 X. These tests were made with the diesel oil employed by the Portland (Oregon) Mosquito Abatement District. Table 3 shows that the diesel oil was at least as effective as fuel oil, and that the two emulsifiers were about equal in performance.

SEMI-FIELD TESTS

Further tests under controlled conditions were run in natural mosquito-breeding waters. Galvanized-iron cylinders 11 inches in diameter and 20 inches long, inside of which screens were soldered 4 inches from the bottom, were set up in the water by forcing them into the bottom soil.

Laboratory tests (data not given) utilizing waters from various sources had shown that various contaminants, such as soil, hay infusion, etc., greatly influenced the effectiveness of oils, particularly the New Jersey pyrethrum larvicide. It seemed im-

[5] An 18-carbon-chain complex amine produced by the Carbide and Carbon Chemical Corporation.

TABLE 3.—Susceptibility of *Aedes vexans* and *A. sticticus* pupae to various types of oil emulsions.

Oil concentrate (figures in percent)	Gallons of oil applied per acre [1]	Number of tests	Total number of pupae	Percent mortality after 24 hours
Fuel oil 66.7, water 31.3, and coconut oil soap 2.0	1.0	4	100	2
	1.3	2	30	3
	2.0	10	200	44
	2.6	5	70	46
	3.3	4	60	70
	4.0	2	40	100
Same as above with pyrethrins 0.07 (New Jersey larvicide)	.67	2	20	35
	1.0	10	180	66
	1.3	1	10	80
	1.67	1	10	60
Fuel oil 97 and Nopco 1216 3	.3	5	90	51
	.5	9	200	88
	.65	10	130	100
	1.3	8	90	100
Diesel oil 97 and Nopco 1216 3	.25	4	100	81
	.5	2	50	100
	1.0	2	50	100
Diesel oil 97 and Amine 230 X 3	.25	5	125	77
	.5	2	50	100
	1.0	2	50	100

[1] The dilution rates were the same as given in Table 1.

portant, therefore, to conduct laboratory-type tests, yet in the same water and under conditions as they exist in the field. The method proved satisfactory. Larvae from the breeding area were collected with dippers and placed in the water inside the cylinders. One hundred fourth-instar larvae (practically all *A. vexans*) were used in each test.

Results with the New Jersey larvicide and the oil emulsion made with Nopco 1216 are given in Table 4. The data show that under simulated natural conditions fuel oil alone emulsified with Nopco 1216 was far more effective than fuel oil containing pyrethrum and emulsified with coconut oil soap.

The tests in the cylinders fully confirmed the findings in the laboratory. Actually the results with the Nopco oil

TABLE 4.—Comparative effectiveness of the New Jersey larvicide and the oil emulsion containing Nopco 1216 against fourth-instar larvae of *Aedes vexans* in natural breeding areas. Semi-field tests; emulsions prepared with water from the breeding area.

Rate of application (gallons per acre)		Number of tests	Percent mortality after 24 hours
Emulsion	Oil		
New Jersey Larvicide diluted 1:9			
15	1.0	1	24
25	1.7	2	74
35	2.3	2	82
Fuel oil (96%) plus Nopco 1216 (4%) diluted 1:6.5			
10	1.3	1	99
15	2.0	2	100
25	3.3	1	100

emulsion were more favorable in the semi-field tests than in the laboratory.

FIELD TESTS

Several field tests with diesel or fuel oil emulsified with 4 percent of Nopco 1216 were made under a wide range of conditions in the summer of 1941. The emulsions were prepared by diluting the mixture with water from the breeding area. The sprays were applied with a knapsack sprayer.

C. M. Gjullin and W. W. Yates of the Portland laboratory conducted additional tests during 1942, the results of which have been reported in publication E-587.

The field tests were conducted against a number of species, both larvae and pupae, and in various types of breeding areas, including heavily polluted waters. Excellent control was obtained in all tests when the total amount of oil applied amounted to 5 gallons per acre.

DISCUSSION

These investigations definitely established that the emulsifier can have a marked influence on the efficacy of oil used in emulsions against mosquito larvae and pupae, and particularly against pupae. With Nopco 1216 and Amine 230 X as emulsifiers a given quantity of oil was more toxic to pupae than to larvae.

The addition of emulsifiers such as Nopco 1216 greatly increased the spreading properties of the oil. In the opinion of the writer the reason for increased larvicidal action of the oil containing the emulsifiers was due to its lowered surface tension, which permitted penetration into the tracheal tubes of both larvae and pupae more readily. It appeared that the effects on the larvae were largely physical—that an oil film spread over the spines and walls of the siphon tubes and made it impossible for them to remain suspended at the surface. Evenutally such larvae died by drowning, although the oil alone in sufficient quantities will kill larvae.

That kills were due in part at least to drowning was shown in special tests in which dissolved oxygen was removed from tap water (by boiling or by addition of sodium sulfite) before the oil larvicide was applied. Larvae in treated water containing less than 1 p.p.m. of dissolved oxygen were killed within 2 hours, whereas the same amount of oil in tap water containing about 9 to 10 p.p.m. of oxygen did not kill the larvae until they had been held for 24 hours.

SUMMARY

Tests conducted at Portland, Oregon, during 1940–42 showed that fuel oil or diesel oil emulsions made with the oil-soluble emulsifiers Nopco 1216, Amine 230 X, and B-1956 increased the efficacy of the oils in killing larvae of several species of mosquitoes. A given quantity of oil emulsified with these materials and applied to the water surface was about twice as effective as the same amount of oil emulsified with coconut oil soap. In the laboratory oil emulsified with the oil-soluble emulsifiers was comparable in effectiveness with oil containing pyrethrum and emulsified with coconut oil soap, as used in the New Jersey larvicide. In semi-field tests the oil alone plus the emulsifier Nopco 1216 was two or three times as toxic as the New Jersey larvicide.

Nopco 1216 and Amine 230 X increased the efficacy of fuel or diesel oil against pupae of *Aedes vexans* Meigen to a much greater extent than against larvae. A given quantity of oil applied with these emulsifiers was six to eight times as toxic as when applied with coconut oil soap and about three times as toxic as the coconut oil soap emulsion containing pyrethrum.

Field tests against various species of larvae and pupae confirmed the laboratory results.

STUDIES OF *CULICOIDES* IN THE PANAMA CANAL ZONE (DIPTERA, HELEIDAE)

STANLEY J. CARPENTER [1, 2]

The small blood-sucking Diptera of the genus *Culicoides,* family Heleidae, occur in such large numbers in and near tidal marshes on both the Atlantic and Pacific coasts of Panama that they cause a great deal of annoyance to man. Owing to their small size, they find no difficulty in passing through screen meshes and are troublesome within houses. *Culicoides* are so numerous at times on one Army post (Fort Kobbe) in the Canal Zone that they are often extremely annoying inside family quarters and barracks and interfere with outdoor activities.

Since August, 1950, the writer has conducted studies on these insects at Fort Kobbe, located just west of the Pacific entrance to the Panama Canal. Fort Kobbe is bounded on the east and northeast by Farfan swamp, an extensive tidal marsh of several hundred acres, which has been subject to some flooding with saltwater at high tide and with fresh water following heavy rains. Most of the *Culicoides* breeding in this area takes place in this tidal marsh. The principal drainage of the swamp is effected by the Farfan River and its tributaries, which consist of many small drainage ditches.

LARVAL STUDIES

Methods of Study. In searching for the immature stages of *Culicoides,* techniques employed by Painter (1926), Dove *et al.* (1932), Hill (1947) and others were evaluated. After considerable exploratory work had been done, the following technique was found to be satisfactory for locating heavy breeding of *Culicoides* in Farfan swamp and was adopted. Mud samples from different locations were collected in wide mouth jars, each holding 400 cc. of material. The samples were taken from the top 1½ to 2 inches of the surface mud. Each jar was given a collection number, carried to the laboratory, flooded with tap water and allowed to stand overnight. During the following morning, the water covering the mud was gently agitated and transferred in a pipette to a syracuse watch glass for examination under a stereoscopic microscope. Counts from each sample were based on examinations of 6 watch glasses of water and surface material.

The larvae could often be seen swimming in the water around the edge of the jar. The larger larvae were often visible with the naked eye between the mud and the glass. Each site in the swamp from which a sample was obtained was marked with a wooden stake holding a tin plate through which the collection number was punched. Collection data, compiled for each sample, included location, description of soil, tidal height and density of shade.

Larval Collections. Five hundred fifty-two mud samples were collected from different locations near Fort Kobbe and examined from June through December, 1950. Three hundred forty-two duplicate samples were taken and examined during the testing of larvicides and while making observations on seasonal occurrence of the immature stages of *Culicoides.* In general those collecting stations yielding larvae during the earlier months of the work continued to be positive during successive

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[1] Colonel, MSC, Entomologist, United States Army Caribbean, Fort Clayton, Canal Zone.

[2] The author gratefully acknowledges the assistance rendered by the following persons and organizations: Colonel Francis P. Kintz, Surgeon and Lt. Colonel W. C. Burry, Chief of Preventive Medicine, United States Army Caribbean; Mr. F. C. Henderson, Malaria Control Force, Army Medical Service; and personnel of the 25th Preventive Medicine Survey Detachment. The species reported were confirmed by Mr. W. W. Wirth of the U. S. National Museum.

FIG. 1. Farfan tidal marsh during the dry season. *Culicoides* breed in these low areas in the swamp during the rainy season, from May to January.

FIG. 2. *Culicoides* breeding is limited mostly to muddy areas along streams and ditches during the dry season.

weeks until after the onset of the dry season. Full grown larvae and pupae were more numerous in the samples taken toward the end of the rainy season, October to January. The soil in the swamp is mostly dark loam and contains large amounts of decomposing organic matter. This dark loam varies in depth from a few inches to one or more feet and is too wet to allow motor driven vehicles to be used in this area for larviciding during the rainy season.

Prior to the establishment of tide gates on Farfan River near its entrance to Panama Bay in August, 1950, low areas of the mangrove swamp were subject to flooding or at least moistening with high tides each day and partial drainage at low tide. After the tide gates were installed, heavy rains continued to flood the low areas at frequent intervals during the remainder of the rainy season forming numerous shallow pools and keeping the water table at or very near the surface of the ground. Heavy breeding of *Culicoides* was limited to this type of condition in the tidal marsh. The remainder of the swamp is a few inches higher and the surface partly dries between floodings. Larvae and pupae were rarely found in these elevated areas.

The most prolific breeding of *Culicoides* was in places fully exposed to the sun throughout the day, although some breeding was found in partly shaded areas. Woke (1942) made similar observations during studies conducted at the nearby Naval Station at West Bank.

The low areas in the tidal marsh as described above continued to show heavy breeding of *Culicoides* until after the rains stopped, the water table gradually lowered a few inches and the surface soil became dry and hard (Fig. 1). Larvae were found in the dry season only along the muddy sides of ditches and streams (Fig. 2).

During February, 1951, approximately two months after the end of the rainy season, holes were dug at sites where *Culicoides* larvae were numerous during the rainy season, and samples were examined from various depths. All of these were negative. At that time the holes began filling with water between 8 and 12 inches below the surface. Many other mud samples taken from underneath the dry surface crust were examined for larvae during the dry season, but all these were negative.

On one occasion the writer found a full grown *Culicoides* larva following the flooding of a bamboo section which had been used in the forest as a mosquito breeding trap, carried to the laboratory and kept in a dry condition for one month. Following this observation, it seemed possible that *Culicoides* might pass the dry season as larvae in partly dry soil near the surface or in the mud farther below the surface. A considerable amount of sampling has since been done in the tidal marsh during the dry season and there have been no indications that they do so.

Since *Culicoides* continue to breed along the ditches and streams throughout the dry season, it seems likely that breeding gradually builds up in the main swamp after the rains begin in May until a peak of emergence is reached in the late summer and fall. The fact that full grown larvae and pupae are seldom numerous in the main swamp until late summer would lead one to believe that there is a single brood developed between May and January in these areas. However, on the other hand, emergence may be continuous along the ditches and streams where there may be as many as two broods developed in a year's time.

ADULT SURVEYS

Horse-baited Traps. After several collecting methods had been evaluated for measuring adult densities of *Culicoides* the following was adopted. Sheets of white bond paper (8 by 10½ inches) were treated with castor oil and mounted on plywood boards. The boards were set in an upright position in a horse-baited mosquito trap (Fig. 3) and left overnight. The horse served as an attractant and the *Culicoides* and other small insects coming in contact with the adhesive paper during the night were caught and held. The

boards were removed from the trap the following morning and carried to the laboratory where specimens were examined and counted.

Narrow strips of wood were attached to the plywood board in the form of a double frame (Fig. 4), thus allowing only a minimum amount of the adhesive paper to come in contact with the board. Wherever the paper came in contact with the board, the oil was usually drawn off to the extent that it would not catch and hold *Culicoides*.

Culicoides catches from four horse-baited traps operated at Fort Kobbe totaled some 700,000 specimens. One trap, number 3, was located on the lawn adjacent to family quarters only a few hundred feet from the edge of Farfan swamp. Traps 2, 4 and 5 were located in an area of heavy second growth timber mixed with low undergrowth near a small group of civilian dwellings, about three-fourths mile northeast of the main post and between one-half and three-fourths mile west of Farfan swamp. Traps 2 and 3 began operation August 7, 1950, while traps 4 and 5 did not begin operation until September 11. Six adhesive papers were used in each trap each night of operation, except trap 3 where 12 adhesive papers were used from August 7 to September 7. Occasionally one or two boards were dislodged during the night and destroyed by the horse. Traps 3, 4 and 5 were used occasionally for testing insecticides. Trap 2 served as a control during the entire period of study.

The areas adjacent to and surrounding trap 3 were treated on numerous occasions during the year either with heat-generated DDT aerosol dispersed by a fogging machine or benzene hexachloride suspension dispersed as a wet spray with a mobile mist blower. None of these attempts to control *Culicoides* appeared to affect the nightly catch of biting midges in horse-baited trap 3.

The screen mesh of horse-baited trap 4 at Fort Kobbe was treated with 5 per cent DDT applied with a paint brush September 12, 1950, and there was a sharp reduction in the number of adult *Culicoides* caught on adhesive papers in this trap during the remainder of the week. The weekly catches from trap 4 remained somewhat lower than those obtained from the nearby traps 2 and 5 for a period of about 2 months. Catches made in horse-baited traps indicate that there is a gradual buildup in population of *Culicoides* during the rainy season until a peak in abundance is reached in November and December. The population of these biting midges decreases rapidly after the onset of the dry season in January due to the limited areas suitable for continuous breeding. Data are not available at this time on population trends during the period from May to August. However, the complaints made by residents of the area would indicate that *Culicoides* are seldom extremely annoying except from September to January.

Light Trap. A New Jersey type light trap was operated at the edge of the jungle on an elevation only a few hundred feet from the Farfan swamp, beginning in December, 1950. Catches of *Culicoides* with the light trap were usually light when compared with those obtained from horse-baited traps. However, the light trap proved useful for catching males and females for identification to species.

Culicoides furens (Poey) comprised about 94 per cent of the total Heleidae taken in the light trap. About 5 per cent of the specimens caught were *Culicoides guttatus* (Coq.) and less than 1.0 per cent were other species of the family Heleidae. Other species identified from Fort Kobbe are *Culicoides* sp. nr. *hoffmani* Fox, *Culicoides dasyophrus* Macfie, *Culicoides rozeboomi* Barbosa and *Monohela* sp. Several specimens of *Atrichopogon* sp. were identified from a horse-baited trap catch from Fort Clayton, about five miles north of Fort Kobbe.

Habits of Adults. Culicoides are seldom annoying except near their breeding places; however, collections were very heavy in horse-baited traps 2, 4, and 5 at Fort Kobbe between one-half and three-fourths mile from the tidal marsh. A light trap was operated in the vicinity of the above horse-baited traps on February 19 to 21 for an

average of two hours each night and the following *Culicoides* were captured: *C. furens,* 2 males, 72 females; *C. guttatus,* 1 male, 2 females; *Culicoides* spp., 4 females.

Boards with adhesive papers attached were set overnight in one area at Fort Kobbe during heavy flights of *Culicoides* in an attempt to determine the direction of flight but each time catches were greatest on the leeward side of these traps, thus indicating that the adults may avoid flight in direct wind. It was also noted throughout the study that catches were always greater on calm nights than when steady winds blew.

Adhesive paper traps placed in windows at elevations of 7, 23, and 35 feet above the ground on three floors of a building caught *Culicoides* at each level in about equal numbers. These catches indicate that these midges may enter buildings at any average height whenever personnel are inside to attract them.

Culicoides were reported as annoying in family quarters from dusk until dawn, but were rarely encountered biting in the daytime except in dense jungle areas or on cloudy days. Thirty-minute catches were made throughout the night using adhesive papers in horse-baited trap 3 at Fort Kobbe. The activity of these insects varied little through the night.

Boards with adhesive papers attached to both the bottom and the top were placed in a horizontal position on stakes at different heights and set in the jungle (Fig. 5) in an attempt to determine the preferential resting places of *Culicoides* in the jungle. Three of these stakes (Fig. 5) were set and operated during 5 days in January, 1951. Two hundred seventy-eight *Culicoides* were captured on these boards 94% of which were taken on the adhesive papers mounted on the bottom surface of the boards. The height of the boards ranged from 8 to 68 inches above the ground and there was no significant difference in the numbers of *Culicoides* captured at the different levels. A white cloth treated with castor oil was carefully draped over an area of ground litter to form a small tent. The leaves and dead twigs making up the ground litter were agitated and 8 adults were captured on the oil treated inner surface of the tentlike canopy as they arose from this material. The fact that *Culicoides furens* in this area preferably rest on the under side of jungle foliage and among the ground litter and are not generally disturbed when insecticides are applied as wet sprays, may explain why this method of control is rarely effective against *Culicoides* in this area.

Color Attraction. Hill (1947) noted in England that when collectors wore light-colored apparel very few *Culicoides* would alight on them; on the other hand, when collectors wore dark clothes, great numbers would alight on their clothing within a few minutes. Hill then hung dark pieces of cloth on bushes and the adult flies were collected from them as they alighted. Kettle (1949) used black adhesive traps instead of white, as he says, to take advantage of the attractiveness of black to female *Culicoides.* Dorsey (1947) used lanterns with red, green, blue, yellow and clear globes on Peleliu Island to determine if one color were more attractive to *Culicoides peleliuensis* Tokunaga than another. He found that an intense clear light attracted more of the gnats than all of the other colors.

The writer compared castor oil treated adhesive paper traps of different colors in horse-baited traps with a white standard at Fort Kobbe. In all of these tests, the white papers proved to be superior to black, yellow, red or green papers.

FIG. 3. Horse-baited trap used for sampling *Culicoides* and mosquito populations at Fort Kobbe.

FIG. 4. Box containing boards and adhesive papers used for catching *Culicoides* in horse-baited traps.

FIG. 5. Horizontal boards mounted on stakes for determining resting position of *Culicoides* in the jungle. Each board has an adhesive paper mounted on both the upper and lower surfaces.

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SUMMARY

Mud samples were collected and examined from 552 locations in Farfan swamp, near Fort Kobbe, for the purpose of locating the important breeding places of *Culicoides* in the area. Heavy breeding of biting midges was generally confined to low areas which were constantly saturated or covered with shallow water or were subjected to frequent flooding.

Castor oil treated papers set in horse-baited traps proved to be more satisfactory than light traps or hand catches for measuring densities of adult *Culicoides*. This measure is described in some detail and is presented as a new and improved method for sampling *Culicoides* populations in this area.

Data presented in this paper indicate that the *Culicoides* population in this area is extremely low during the dry season due to the limited areas suitable for continuous breeding of these insects. Following the onset of the rainy season in May the population gradually builds up until it reaches its greatest height between the period of late September through the end of December.

Light traps were valuable for capturing male *Culicoides* and for determining what species were in the area, but were not considered equal to horse-baited traps equipped with adhesive papers for population studies.

Observations made in the jungle near Fort Kobbe indicate that *Culicoides* generally rest during the daytime on the underneath surface of foliage and among the ground litter.

White adhesive papers proved better than either black, red, yellow or green for catching *Culicoides* in horse-baited traps.

Literature Cited

DORSEY, C. K. 1947. Population and Control Studies of the Palau Gnat on Peleliu, Western Caroline Islands. *Jour. Econ. Ent.*, 40 (6):805–814.

DOVE, W. E., D. G. HALL AND J. B. HULL. 1932. The Salt Marsh Sand Fly Problem (*Culicoides*). *Ann. Ent. Soc. Am.*, 25(3):505–522.

HILL, M. A. 1947. The Life-Cycle and Habits of *Culicoides impunctatus* Goetghebuer and *Culicoides obsoletus* Meigen. Together with some Observations on the Life-Cycle of *Culicoides odibilis* Austen, *Culicoides pallidicornis* Kieffer, *Culicoides cubitalis* Edwards and *Culicoides chiopterus* Meigen. *Ann. Trop. Med. Parasit.*, 41(1):55–115.

KETTLE, D. S. 1949. An Attempt to Control *Culicoides impunctatus* Goetghebuer in Scotland by Barrier Spraying. *Ann. Trop. Med. Parasit.*, 43(3–4):284–296.

PAINTER, R. H. 1926. The Biology, Immature Stages and Control of the Sandflies (Biting Ceratopogonidae) at Puerto Castilli, Honduras. *An. Rept. Med. Dept., United Fruit Co.*, 246–262.

WOKE, PAUL. 1942. Investigations on Biting Sandflies in the Panama Canal Zone. (Unpublished Manuscript).

Salt Lake City in March!

See Page 224 for notice of meeting!

RECONNAISSANCE OF MOSQUITOES, PUNKIES, AND BLACKFLIES IN SOUTHEAST ALASKA

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General

Three rapid survey trips were made in Southeast Alaska during May, June, and July, 1949, to ascertain the principal insect problems of the larger towns. Very little entomological information, apart from conflicting popular claims, was then available to Alaskan health or military authorities to indicate the prevalence and species of mosquitoes, blackflies, and punkies. It was believed that even a superficial survey of key areas would be useful and of interest.

Physically, Southeast Alaska is a maritime region of countless mountainous islands and peninsulas with highly dissected shore lines. Excessive precipitation maintains numerous glaciers, some vast, and gloomy coniferous forests interspersed with a patchwork of extensive upland bogs and lakes from which drain torrential streams.

Foot surveys were made along the shore roads at Ketchikan, Wrangell, Petersburg, and Juneau, usually as far as 6 miles out of town. The more extensive highway system from Juneau was covered by car. Supplementary collecting was done on five climbs up to 3,000 feet at Ketchikan (Deer Mountain), and about a thousand feet up into the forest of Douglas Island near Juneau (Ski Path).

Only simple collection equipment for mosquitoes, including dipper for larvae and chloroform killing tube for adults, was used. For blackflies, a small net proved useful since many Alaskan species, although attracted to the proximity of man, are reluctant to alight or bite. The trouser legs were turned up for the collection of punkies on the lower limbs. Time, weather, and cover were recorded for adult collections, and water temperature, pH, color, and turbidity for larval habitats. Vegetation associated with mosquito breeding was collected and identification of the dried plants was furnished by Dr. C. L. Porter of the University of Wyoming. Dr. Alan Stone and Dr. Willis Wirth of the U. S. National Museum kindly identified the insects.

In Southeast Alaska mosquitoes constitute a much less serious problem than they do in Central or Arctic Alaska. None of the towns surveyed has a local mosquito problem of great practical importance. Dwellings and even hotels are seldom screened and it was usually difficult to collect adult specimens within the towns. However, it was extraordinary to find that very large larval populations of *Aedes aboriginis* and *punctor* occurred in May on the extensive upland bog encircling Petersburg. Similar heavy breeding obtained on a bog which reaches from near the tip of Wrangell Island south into Wrangell. Biting adult *Aedes* were collected on these bogs a month later in small numbers, but not in the adjacent streets where mosquitoes were declared by residents to be no problem.

In two summer resort localities on flats near the mouths of glacial rivers large populations, mostly *Aedes communis,* gave serious trouble. One area, Taku Lodge, on the fjord of the same name near Juneau, was surveyed on May 11, when concentrated populations of first and second stage *Aedes* larvae (upwards of 50 per dip) were noted on about a square mile of coastal marsh. They were breeding in the melting snow pools, some open, some in alder thickets. The area was not revisited, but the Alaska Department of Health reported high landing rates beginning the

* This work was done as a part of the Alaska Insect Project supervised by B. V. Travis of the U. S. Bureau of Entomology and Plant Quarantine.

first week of June. Their control program instigated during June and July, using a compressor mounted on a jeep to disperse DDT aerosol, was reported to have given considerable relief at the lodge itself. The other situation, the Boy Scout Camp about 18 miles from Juneau on the Eagle River flats, proved to have a much larger breeding area. Here a serious pest problem was evidenced by landing rates (trouser-front counts) of 15 to 50 dark-legged *Aedes* in mid-afternoon on June 17. The larvae had bred in innumerable pools and potholes on the open flats overgrown with several species of *Carex* but free of *Myrica gale* or *Betula nana* bushes characteristic of such coastal flats in Central Alaska. There were at least two cases here in 1949 of campers requiring hospitalization from reactions due to mosquito bites. Control operations were undertaken in 1950.

The survey data do not permit a clear-cut evaluation of the importance of punkies in Southeast Alaska. *Culicoides obsoletus* bit viciously at all survey towns, but high densities were encountered only at Ketchikan in August. It is entirely possible, however, that punkies do occasionally occur in great numbers at Juneau and Wrangell as claimed by local residents, and it is likely that other inhabited areas with serious *Culicoides* problems do exist in Southeast Alaska.

Blackflies of several species were prevalent in the environs and within two of the towns, Ketchikan and Petersburg, in July and August. However, the tendency of all blackflies to stop short of attacking man, which has been observed in Central Alaska also was marked here. Thus, when very numerous, the flies circled in clouds around the head with only an occasional one landing on the forehead, nose or ears, and then usually taking off again almost immediately. This constant landing near the eyes and crawling into sensitive organs is extremely annoying.

The results of blackfly bites were observed on two occasions at Ketchikan. On the first (in July), two bites close together on a temple were received unknowingly in the rain. Large swellings appeared in less than 2 hours, and persisted unchanged for 24 hours and were still about half the maximum size after 48 hours. They were uncomfortable but did not itch. *Prosimulium hirtipes* was believed to have caused the bites. In the second instance (in August) when Ketchikan had high counts of *Simulium venustum* (white socks) on the wing, six were allowed to settle on an exposed shin. They bit almost simultaneously in 10 minutes, filled with blood, left a drop at the site, and flew off heavily. The bites were encircled with ink. Swellings appeared within half an hour which disappeared almost completely in less than 24 hours. Three bites, which were deliberately scratched, exuded lymph for about a week when picked at. There was nothing painful or noteworthy about these bites. They did not itch as do mosquito bites. Thus, in the main, little evidence to warrant control of blackflies was found.

LARVAL HABITATS

Several typical larval habitats appear to have produced most of the blackflies or mosquitoes encountered in Southeast Alaska. The characteristic upland bogs have been mentioned as important mosquito producers, while blackflies develop in the drainage creeks from the bogs. Roadside borrow pools represent a well-marked type of habitat which furnished almost all the collections of *Culiseta* larvae. No permanent ponds with such floating aquatics as *Lemna, Potamogeton,* and *Nymphaea,* in which the sole species of *Anopheles* and *Culex* breed in Central Alaska, were studied.

Upland Bogs.—The deep sphagnous bogs, generally on slopes, are extensive and widespread in the region. From the air they may be seen at various elevations, usually strewn with potholes of all sizes and shapes and generally virtually free of trees other than the bushy little lodgepole pine. The bogs where collections were made were along the ski path on Douglas Island (near Juneau), near Connell Lake (Ketchikan), north of Wrangell, and at Petersburg. They have a characteristic

association of larger plants, usually including: *Pinus contorta* Loud., *Ledum groenlandicum* Oeder, *Kalmia polifolia* Wangenh., *Dodecatheon* sp., *Drosera rotundifolia* L., *D. anglica* Huds., *Gentiana douglasiana* Bong., *Juniperus communis* L. var. *montana* Ait., *Platanthera dilatata* (Pursh) Lindl., *Nephrophyllidium crista-galli* (Menz.) Gilg., *Menyanthes trifoliata* L., *Oxycoccus microcarpus* Turcz., and *Pinguicula vulgaris* L.

The pothole water of the bogs was much diluted with melted snow in May when *Aedes* larvae were present. This pale (straw-colored) water, with a pH of about 5.0, became darker (tea-colored) and more acid in June. Reactions of 4.0–4.5 were usual in July. However, no mosquito larvae were collected from the bogs in July.

Bog Streams.—The streams draining these upland bogs are very numerous. The water in several observed in late July at Petersburg was tea-colored, with pH readings of 4.2 to 4.5. In the bogs, the streams are intermittent through the peat. In the forest zone where they flow under dense canopies of western hemlock and Sitka spruce, they tumble through roots and rocks as small torrents of foaming white water. Effluent sections near the sea, though still fast, run over sand and gravel. Even here the streams are still easily identified as bog streams by their tea-colored, acid water. These bog streams were important breeders of blackflies other than *Simulium venustum*.

Roadside Borrow Pools.—Under this term are included pools in the highway ditches or in muddy flats, mostly free of vegetation and usually in clay or shale basins. Some have growths of *Carex* spp. and many contain a good deal of detritus. The water is clear or turbid, rarely stained a pale straw-colored, reaction less acid than pH 5.2 and may be neutral or slightly alkaline. The water temperatures followed average air temperatures (50°–60°F.). During prolonged rainy weather these pools usually develop inlets and outlets and become turbid. In this condition they rather belie a usual rule of thumb that Alaskan mosquitoes are absent in flowing waters, for such roadside pools are a habitat of predilection of *Culiseta* (chiefly *impatiens*) larvae.

Torrents.—Cascades other than bog streams are frequent and variable about Juneau, Ketchikan and Wrangell. Almost all are cold. The average temperature of about twenty torrents in mid-June was only 49° F. Most are fed in part by melting snow in the mountains, and apparently warmed by contact with the air in numerous "bridal-veil" falls. At Juneau several of these torrents were still bordered by snow drifts near sea level in June and had temperatures in the low forties. At Wrangell 45° was the average temperature of this stream-type the middle of June. Blackfly larvae were collected in most of them with considerable difficulty, but the collections were small and the larvae also generally small. There were exceptions, of course. For example, the large torrent emptying near the Juneau dump, sections of which are so steep that the water might be described as heavy spray, surprisingly supported large simuliid larvae on sticks. In general, though no thorough surveys for larvae were made in torrents, the small numbers of larvae found and low adult counts suggest relatively low blackfly production.

Larger Streams.—The rivers of the region, being fed by glaciers, are turbid with glacial milk and were not studied. Several clear streams with flows of 15–50 c.f.s., which drained lakes or flowed in valleys rather than through gorges, were surveyed. Such watercourses are fast, though much slower than torrents, being mostly rapids or riffles interrupted only by occasional turbulent pools. They were generally warm (above 50° F. in June). In Ward Creek near Ketchikan and Nugget Creek near Juneau, *Simulium venustum* was found, usually along with other species of blackflies.

Notes on Species

Mosquitoes:

* *Aedes aboriginis* Dyar—Juneau, Ketchikan, Wrangell, Petersburg. Larvae

were collected in May, June, and July in roadside borrow pits devoid of vegetation. The species was associated at Wrangell with *Aedes pullatus* and *punctor;* at Petersburg with *Culiseta impatiens.*

A. communis, Deg.—Juneau. Only from Juneau where larvae were associated with *A. punctor* in *Carex* pools.

A. excrucians (Walk.)—Wrangell. A single adult female was collected biting at Rainbow Creek near Wrangell, July 30.

A. impiger (Walk.)—Juneau. Seventeen larvae from a roadside pool near Juneau, May 11.

A. pionips Dyar—Juneau. Fifty-four larvae dipped near Lemon Creek, Juneau, May 11.

* *A. pullatus* (Coq.)—Wrangell, Juneau. Seventeen larvae collected at Wrangell in bare, open gravel borrow pits, May 14, associated with *A. aboriginis.* Nine females taken biting at Mendenhall Glacier, Juneau, July 25.

* *A. punctor* (Kirby)—Juneau, Ketchikan, Wrangell, Petersburg. The larvae of this species predominated in collections from upland bogs. At Wrangell and Petersburg there were very large populations. Inasmuch as the bogs include vastly more area than all other mosquito larval habitats of the region, it is likely that *A. punctor* is the most important pest mosquito.

Culiseta alaskaensis (Ludl.)—Haines. This conspicuous species, which is very common and widespread in Central Alaska, was collected only at Haines as biting adults.

* *Culiseta impatiens* (Walk.)—Juneau, Ketchikan, Wrangell, Petersburg, Haines. The larvae were common from May to August in roadside borrow pools and ditches. Females which emerge in July and August evidently do not bite until the following spring. They were readily collected biting as late as mid-June. A *Culiseta* egg raft presumably of this species was collected at Wrangell June 21. Either the females are extremely long-lived or there is a second brood.

Culiseta incidens (Thoms.)—Ketchikan. Dr. Stone stated regarding this identification of 21 larvae from Ketchikan, June 26: "It is possible that these are *alaskaensis* larvae, but I doubt it." No *C. alaskaensis* were seen south of Haines.

Culiseta ? maccrackenae D. & K.—Wrangell. Of a puzzling collection of 14 larvae from a Wrangell roadside ditch, Dr. Stone says: "If correctly determined a considerable extension of its range. I can find no disagreement with larvae from California."

Punkies:

* *Culicoides obsoletus* (Mg.)—Juneau, Ketchikan, Wrangell. Biting females were collected in the study areas about each town, except Haines, from June to August. This species is the principal punkie pest of Southeast Alaska. It was apparently most abundant at Ketchikan in August when as many as 15 were observed biting an exposed shin. It seems likely since the species occurs along the coast that the larvae breed in tidal flats. The higher adult counts were uniformly made a mile or more inland in wooded areas, however.

Culicoides unicolor (Coq.)—Haines, Petersburg, Ketchikan. This species, which was common at Haines along the tidal flats, bit fiercely in the late evening on June 14. A single specimen was collected at Connell Lake near Ketchikan on June 19.

Culicoides ? tristriatulus Hoffman—Ketchikan. The identification is tentative. Dr. Wirth has not seen the specimens which were collected at Ketchikan, September 4. He named similar punkies from Valdez *tristriatulus,* however.

Blackflies:

* *Cnephia mutata* (Mall.)—Juneau, Ketchikan, Wrangell, Petersburg, Haines. The adults were collected in all four study areas in June and July and at Haines in June. Next to *Simulium venustum,* it appears to be the most common and widespread blackfly of the region. Though mostly observed at sea level, it was also taken at 3,000 feet on Deer Mountain, Ketchikan, biting, though not aggressively, in the rain. The larvae were not identified.

Prosimulium fulvum (Coq.)—Juneau. Adults of this large, well-marked species were taken only in the Juneau area in June, July, and August. They showed but little inclination to bite.

* *Prosimulium hirtipes* (Fries)—Juneau, Ketchikan, Wrangell, Petersburg. Adults of this common species were taken around each town studied (except Haines) from June to August.

Prosimulium onychodactylum D. & S. —Ketchikan, Juneau. Larvae were collected from Nugget Creek, Mendenhall Glacier, near Juneau and from Ketchikan Creek, Ketchikan, in mid-May. No adults were encountered.

Simulium arcticum Mall.—Juneau. A single adult occurred in a collection of *Prosimulium hirtipes* and *P. fulvum* from a Douglas Island upland bog (near Juneau) July 23.

Simulium costatum Fries—Petersburg. Isolated larvae and pupae were collected from a bog stream at Sandy Beach, Petersburg, May 15. No adults were discovered.

Simulium decorum Walk.—Juneau. A single adult was captured at Nugget Creek, Mendenhall Glacier, near Juneau, July 25.

* *Simulium venustum* Say — Juneau, Ketchikan, Petersburg. This species, commonly called "white socks," is undoubtedly the chief blackfly pest of Southeast Alaska, although it was not collected at Wrangell and Haines and not many were seen at Petersburg. Wherever larger clear streams, especially those connecting lakes, are found, it was abundant. Ketchikan is such an area; adults were abundant there from mid-June to September from sea level to 3,000 feet. They were annoying until after dark in August and have perhaps less reluctance about biting man than other Alaskan species of blackflies.

* Widespread and common species presumably of practical importance.

SEASONAL INCIDENCE OF MOSQUITOES IN THE UPPER COOK INLET, ALASKA

W. C. FROHNE [1]

Little or nothing is known of the densities and seasonal incidence of mosquitoes in most parts of Alaska. There is a real need for quantitative data to supplement the available lists of species. With the present day rapid development of adulticiding control programs, emphasis should be placed more than ever on the vicious, far-ranging, long-lived adults.

Recent mosquito control trials in the vast permafrost areas of the Arctic Slope (Jachowski & Schultz, 1948) and of the

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interior valleys (Blanton *et al.,* 1950) include reports of very high mosquito densities. Stage & Chamberlin (1945) studied abundance and seasonal incidence at a point near the center of the present area of study by analyzing the mosquito catches of a non-baited cutworm moth trap. The present study reports weekly densities of mosquitoes from May 14 to September 17, 1950, as indicated by landing rate counts in 22 localities. About a third of the human population of Alaska lives in the study area.

METHODS

The counting stations were selected near towns, homesteads and other developed areas without reference to mosquito breeding habitats. Mosquito landing rates as determined by Blanton *et al.,* (1950) were chosen to indicate the densities. The area weekly landing rates are totals of the 22 individual locality rates, themselves the highest of several station rates.

Wind, temperature, humidity, and light are factors known to influence insect activity. In order to be reasonably sure that the landing rates reflected density of mosquitoes much more than weather conditions, several precautions were routinely followed: (1) Counts were made on three or four different days each week. (2) Counts were discontinued when wind velocities exceeded 2–3 mph. except at distant stations. (3) Stations were established in shaded, sheltered situations. (4) Instead of a three minute wait at each station before counting, which was found adequate by Blanton *et al.,* the observer waited ten minutes. (The effect of the longer wait was to increase the number of stations positive for mosquitoes rather than to raise the weekly landing rate appreciably). (5) The highest of several landing rates at a station was used. (6) The time and the temperature at ground surface level were recorded.

Six easily recognizable categories of mosquitoes were counted separately. Since it is not feasible to identify specifically adult female mosquitoes of the dark-legged *Aedes* complex the several species were lumped in counting. However, Jenkins (1948) and Sailer *et al.,* (1949) have shown by studies of the larvae in a part of this area that most of these *Aedes* are *punctor* (Kby.) and *communis* (DeG.). The other categories counted were: *Aedes flavescens* Müller; *Aedes excrucians* (Wlk.) plus *fitchii* (Flt.) and Yng.; *Anopheles occidentalis* D. and K.; *Culiseta impatiens* (Wlk.); and *Culiseta alaskaensis.* (Ludl.).

RESULTS

The counts showed the dark-legged *Aedes* to be by far the most important pests. *Culiseta impatiens* was in second place, and *C. alaskaensis* third. Combined landing rates for *C. impatiens* and *alaskaensis* were nearly as great as the peak rates for *Aedes* spp., but the latter had a biting season twice as long. The other categories were local and the data indicate that they can be ignored for control purposes. *Aedes flavescens* was abundant, to be sure, on two widely separated brackish marshes in midsummer, but the species did not disperse in consequential numbers as much as a quarter mile. An occasional *Anopheles occidentalis* bit during a ten day period in late May at an Eklutna station only. *Aedes excrucians* and/or *fitchii* were encountered nine times at five different stations in July and August at low landing rates of no practical importance. Specimens collected on five of those occasions were identified by the tarsal claws (Vockeroth, 1950). Four lots were *excrucians;* one was *fitchii* and *excrucians.*

Landing rates of the dark-legged *Aedes* were unexpectedly low. The highest individual station count was fifteen. For the week of peak densities (landing rate 67), the maximum station count was ten. The average that week (June 18) was 3.05. By way of contrast, in the Interior Blanton *et al.,* (1950) reported average station counts at Birch Hill, near Fairbanks, June 14 and 25, 1948, of 32 and 8 respectively. At Umiat July 2, 1949, Col. Blanton could not count the swarms of landing *Aedes* but estimated the average count at 364. There is, however, evidence that 1950 was

an unfavorable mosquito breeding season in the Upper Cook Inlet. There was only 0.46 inch of precipitation according to the Weather Bureau at Anchorage during the 147 days, January 4-May 11, and a deficiency of 1.46 inches still existed July 25. The *Aedes* and the abnormally reduced larval habitats were, however, widespread. Thus of 386 counts made over the entire season of eighteen weeks 155 (or 40%) were positive for biting *Aedes*.

The two species of *Culiseta* inaugurated the annual mosquito problem at breakup about a month before the earliest *Aedes* appeared on the wing. In fact, a truck equipped with an aerosol dispenser was used against them in the streets of Anchorage. They invaded homes and offices and bit avidly. Unfortunately, the routine landing rates were not determined until the third week in May when the peak of biting activity had passed. *C. alaskaensis* was first observed biting April 18. *Culiseta* landing rates declined to a nadir in July. Remarkably, the emergence in late June and in July and August of a huge population did not appreciably raise the landing rates. In fact, no *C. alaskaensis* was attracted to the observer in the field after July 2. Landing rates, of course, measure only the segment of the population which is inclined to bite. It was thus of interest to study the apparent non-biting habit of these species during the summer and early fall.

A comparison of the biting habits of hibernators from the previous year with mosquitoes which had emerged during the current season was made in the following way: (1) One hundred hibernators (mostly *C. impatiens*) were caught in nature May 14 and 15 and observed in the laboratory until death. They took sugar-water, bit and engorged, and oviposited one or more times during the remainder of May, and June and July. Then during a period of low humidity most of them died. About a dozen, however, rescued with damp towels, lived on through August until the last two died September 14, at an adult age probably exceeding a year. (2) About 20,000 adults of *C. impatiens*, including a few hundred *alaskaensis*, were reared in the laboratory. Except for several hundred, which were progeny of the hibernators of (1), these were dipped from a grossly polluted impoundment in Anchorage. At intervals of a few days all during the latter half of July, and in August and September, the females were observed mating and were offered opportunities to bite. Both sexes took sugar-water, and even a few of the males continued active into October when the last mated pair was observed October 4. But the females would scarcely bite. At the end of September a total of only twenty bites, including some failures to engorge, had been observed. However, in late September and early October after a sudden mortality of more than half of the females, the survivors began to bite the observer at the relatively much higher rate of several each morning. Small numbers also bit a rabbit left in the insectary overnight. By this time no *C. alaskaensis* survived and no fall biting was observed for this species. *Alaskaensis* may not have mated in the laboratory for the spermathecae of two dissected August 24 were empty. Spermathecae of 10 of 11. *impatiens* were full of active spermatozoa. Prior to the onset of fall biting by *impatiens*, unsuccessful efforts to induce biting had been made by refrigeration at 32–39 degrees F. for periods up to two weeks, and by withholding sugar-water. It was concluded that these species actually bite only after aging more than two months or, ordinarily only after overwintering.

The landing rates of *C. alaskaensis* were seen to rise with warmer temperatures for two weeks in June when densities of the species must have been falling. These upward fluctuations are probably activity increases rather than density increases. These hardy hibernators leave winter quarters as early as April 18, and it is improbable that any have not dispersed before the end of May. New emergences from pupae may be disre-

garded since they are few. In July and August when most of the hatch takes place the species has landing rates of zero. Furthermore, the other important categories, viz. *Aedes* spp. and *C. impatiens* showed similar increases in landing rates which were determined at higher temperatures up to 70 degrees F. It was seldom warmer than this after 4 P.M. Increases in landing rates of *Aedes* spp. during the hatching season must be affected by both temperature and new emergences. Pratt (1949) at Fairbanks observed that the activity of *Aedes* spp. decreased rapidly when temperatures were above 80 degrees F. Evidently then, accurate comparisons of densities based on landing rates require counting at similar moderate temperatures over a period of several weeks.

As the landing rates of the *Culiseta* species became low in early June, the rates of dark-legged *Aedes* rapidly rose. The public spoke of a change from big mosquitoes to little ones. The peak of *Aedes* landing rates was reached the week ending June 18. It is interesting to note and indicative of the precise periodicity of Arctic mosquitoes that Stage and Chamberlin (1945) also found the *Aedes* peak in the period June 11–15 in 1944. The mosquitoes then dispersed. The seasonal peak was reached during the week ending July 23, more than a month after the peak landing rates. Biting was experienced at 81% of the counting stations that week. It is therefore a quite mistaken idea that the mosquito problem in this part of Alaska is limited to a relatively short period of about a month in June and July. Rather, the trouble is most acute in this shorter period. The need for anti-mosquito measures extends from the middle of May until the end of August, a period of approximately three months.

SUMMARY AND CONCLUSIONS

Mosquito densities determined weekly by the landing rate method in twenty-two localities of the Upper Cook Inlet, Alaska, May 14-September 17, 1950, indicated:

(1) Relatively low densities prevailed;

(2) The important pests were (a) *Aedes* spp. (chiefly *punctor* and *communis*) during June, July, and August; (b) *Culiseta impatiens* and *alaskaensis* in late April, May, and early June.

(3) *Aedes flavescens, excrucians* and *fitchii,* and *Anopheles occidentalis* were local and/or uncommon and of no practical importance.

References

BLANTON, F. S., TRAVIS, B. V., SMITH, NELSON, AND HUSMAN, C. N. 1950. Control of Adult Mosquitoes in Alaska with Aerial Sprays. *J. Econ. Ent.,* 43(3):347–350.

JACHOWSKI, LEO A., AND SCHULTZ, CARLOS. 1948. Notes on the Biology and Control of Mosquitoes at Umiat, Alaska. *Mosquito News,* 8(4):155–165.

JENKINS, DALE W. 1948. Ecological Observations on the Mosquitoes of Central Alaska. *Mosquito News,* 8(4):140–147.

PRATT, RICHARD L. 1949. Weather and Alaskan Insects. Office of the Quartermaster General, Environmental Protection Section. Report No. 156. 25 pp.

SAILER, R. I., LIENK, S., SOMMERMAN, K. M., MARKS, E. P., ESSELBAUGH, C. O., JEFFERSON, G., RIDENOUR, M., DOVER, L. N. 1949. Mosquitoes (Culicidae). Progress Report of the Alaska Insect Project for 1948. Interim Report No. 0–137, Surgeon General's Office, Dept. of the Army. 88 pp., mimeo.

STAGE, H. H., AND CHAMBERLIN, J. C. 1945. Abundance and Flight Habits of certain Alaskan Mosquitoes as determined by means of a Rotary-type Trap. *Mosquito News,* 5(1):8–16.

VOCKEROTH, J. R. 1950. Specific Characters in Tarsal Claws of some Species of *Aedes.* Canadian Ent. 82(7):160–162.

PLANT FEEDING HABITS OF NORTHERN MOSQUITOES STUDIED WITH RADIOISOTOPES [1]

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and
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Flower visitations and apparent feeding by arctic and subarctic mosquitoes have been observed by a number of investigators. In addition to direct observations of visitation, several mosquito species have been collected with the pollinia of orchids of the genus *Habenaria* adhering to their eyes. (Twinn *et al.*, 1948).

Particular interest centers on the problem as to whether some species of northern mosquitoes may be able to produce viable eggs without a blood meal. The similarity of fractions of vertebrate blood to plant juices strongly suggests the possibility that some species might be able to reproduce on adult food of either blood or plant juices. The relative commonness of flower visitations and the apparent scarcity of mammalian or avian hosts has led some observers to suggest that plant food may well be a normal diet. Trembley (1947) has shown that *Aedes atropalpus* (Coq.) does not require a blood meal in order to lay viable eggs, although the species is a vicious biter when offered a blood meal under laboratory conditions.

As part of a more extensive study of the adult feeding habits of northern mosquitoes, it was considered necessary to first demonstrate that mosquitoes actually ingest plant food, probably nectar, when visiting flowers. Radioactive isotopes offer an admirable tool for such problems. Studies were undertaken during the summers of 1949 and 1950 at Churchill, Manitoba. Twenty-five species of tundra flowers were collected and their stems cut carefully under water. The stems were put into a solution of radiophosphorus for about 24 hours until the flowers had become radioactive. The flowers were then put into field and laboratory cages with *Aedes communis* (DeG.) mosquitoes which had been reared from larvae in the field.

P^{32} was selected for the experiments because it is taken up and accumulated by plants and insects, is readily available and relatively safe to handle, emits only beta rays which are easily measured with field instruments, and has a 2 week half life which is suitable for these experiments. The P^{32} was supplied as $KH_2P^{32}O_4$ from the Atomic Energy Project, Chalk River, Ontario. Counts of radioactivities of the flowers and insects were made with Marconi and Beckman MX5 beta-gamma survey meters. All counts of radioactivity are at 1 cm. from the Geiger-Muller tube, and have been corrected for background and coincidental counting. Background averaged 38 counts per minute (cpm) on the basis of several hundred measurements.

Results

Data are presented from three experiments attempting to show that the mosquitoes actually ingest plant juices or nectars.

During the summer of 1949, West put activated flowers into field cages measuring

[1] These studies were conducted as a part of a program of studies of biting flies in northern Canada being sponsored by the Defence Research Board.

The writers are indebted to Dr. C. R. Twinn, in charge Household and Medical Entomology Unit, Division of Entomology, Science Service, Canada Department of Agriculture, for cooperation, and to Dr. K. C. Fisher, Superintendent, Defence Research Northern Laboratory, for providing facilities.

6 ft. on a side and 8 ft. high. The cages contained large populations of *Aedes communis* adults which had been reared from the larval stage. At no time was a significant proportion of the caged population observed to visit any of the 25 species of flowers tested. Nearly one-third of the recorded visits were made by females. More than 200 mosquitoes, observed to have visited and to have actively probed in flowers, were measured for radioactivity. Only three individuals, one female and two males, which had visited pistillate flowers of *Salix arctophila* showed significant activity (three to four times background count). It was concluded that experimental conditions were unsatisfactory for the objective in view. Flower activities of 200–800 cpm (individual florets) were possibly too low for a significant activation of mosquitoes. It is possibly significant that *Salix* catkins registered the greatest activity (up to 3000 cpm) per catkin. No significance was attached to the relative attractiveness of the various flowers under caged conditions.

To further determine the amount of P^{32} required to activate flowers and mosquitoes, three nasturtium flowers and one dandelion were put in water containing 0.5 microcuries of P^{32}/ml. This experiment was undertaken in the laboratory at Army Chemical Center, Md. Fifty male and fifty female *Culex pipiens* L. were put in a cage with the flowers and after two days 20 males showed a radioactivity of 120 cpm and 20 females 150 cpm (background average 30 cpm). The nasturtium flowers averaged 450 cpm and the dandelion 240 cpm. These results are significant but indicated that a higher concentration of P^{32} is required for larger scale testing.

The following experiment was carried out by the authors during the summer of 1950 at Churchill, after completing the above preliminary tests.

Larvae of *Aedes communis* were collected from pools and reared to the adult stage in enamel pans in a large outdoor cage. For experimental purposes adults approximately one week to 10 days old were removed to small laboratory cages (ca. 12″ × 12″ × 18″). The species of flowers tested were selected on the basis of importance for mosquito feeding as observed in the field and included *Ledum decumbens, Rhododendron lapponicum, Dryas integrifolia, Rubus chamaemorus, Habenaria obtusata.* Freshly picked flowers were brought into the laboratory and the stems were cut short under water. Bunches of flowers were placed in small vials so that the ends of the stems were in the P^{32} solution. Each vial contained 8 ml. of P^{32} solution having a concentration of 9.1 microcuries per ml. The stems were inserted so that no mosquito could come in direct contact with the P^{32}.

The vials were set in small beakers and immediately placed in cages containing both male and female *Aedes communis.* During an exposure period of two to three days, numerous mosquitoes were observed feeding in the flowers. At the end of the exposure period the mosquitoes were killed and measurements of radioactivity were taken. Some mosquitoes had died during the experiment, but they were included with live ones for measuring. Since the objective was to find out if plant juices and nectars were ingested, variable numbers and ages of flowers and mosquitoes were permissible.

It was found that a significant proportion of the mosquitoes became radioactive from ingesting plant material from flowers which gave counts ranging from 31,000 to 800,000 per flower. Counts on individual mosquitoes ranged from 20 to 6970. Averages of separate counts of males and females caged with the several species of flowers ranged from 315 to 1210. The percentage of radioactive individuals ranged from 9 to 93. No greatly engorged adults were observed during the course of the experiments, and none were tested for egg laying or viability. No harmful effect on egg laying would be expected from the amount of radiation accumulated in these mosquitoes, according to the results of Hassett and Jenkins (1951).

Summary

1. Various species of northern flowering plants take up and retain radiophosphorus when their stems are put in a solution of this radioisotope.
2. Under laboratory conditions *Aedes communis* males and females visit flowers and ingest plant juices and nectars as shown by their accumulation of P^{32} from the activated flowering plants.
3. Northern mosquitoes have frequently been observed to visit and probe several species of arctic and subarctic flowers. Proof in the present studies that the mosquitoes ingest plant juices lends indirect support to the hypothesis that some arctic mosquitoes may be able to produce viable eggs without a blood meal from a mammalian or avian host.

Literature Cited

Hassett, C. C. and Jenkins, D. W. 1951. The uptake and effect of radio-phosphorus in mosquitoes. *Physiol. Zool.* 24(3):257–266.

Trembley, H. L. 1947. Biological characteristics of laboratory reared *Aedes atropalpus*. *J. Econ. Ent.*, 40(2):244–250.

Twinn, C. R., Hocking, B., McDuffie, W. C., and Cross, H. F. 1948. A preliminary account of the biting flies at Churchill, Manitoba. *Can. J. Res. D.*, 26:334–357.

TAGGING TECHNIQUE FOR USE IN FLIGHT RANGE STUDIES OF THE *HIPPELATES* EYE GNAT

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A special technique had to be worked out in order to tag *Hippelates* with a dye. The regular method of tagging and detecting mosquitoes in flight range studies has many pitfalls when it is applied to gnats. The first attempt at tagging was done with a mixture of fluorescein dye and gum arabic applied as a dust to the gnats. Then the dusted gnats were subjected to a very high humidity in order to make the dye-arabic mixture stick. The result was that the gnats stuck to each other. Very few gnats recovered. Next an aqueous solution of the fluorescein dye was sprayed directly on the gnats, but as in the first case, very few gnats recovered from this operation. Next a plain dust of fluorescein dye was applied to the gnats. About 90% of the gnats recovered from the operation, but the fluorescent light would not activate the dye unless it was in contact with water, or had been in contact with water. It was discovered that when the dead gnats were put in water even the smallest particle of dye would go into solution and was detectable with the fluorescent light.

To test this technique about five hundred gnats were dusted with the powdered fluorescein dye and released in the field one hundred feet from a Tinkham Gnat Trap. The next day the catch from the trap was brought into the laboratory, killed and tested. Only a few gnats at a time were put into the water and observed under the mineral light. It was found that some of the gnats had ingested the dye and by crushing them the dye could be detected. By crushing the gnats it was also discovered that some of the very small dye particles were caught in the sutures of the insect. Apparently, the surface tension of the water prevented the wetting of the dye in the sutures. It is planned to try a wetting agent in the water, such as Triton X-100, in order to reach the small dye particles without crushing the gnats.

From the first test out of the hundreds of gnats caught each day 35 gnats were recovered on the first day, the second day no gnats were recovered, the third and fourth day (a week-end) one gnat was recovered, the fifth day one gnat was recovered, the sixth day no gnats were recovered and on the seventh day no gnats were recovered.

Further tests are in progress to determine other phases in the flight range of the *Hippelates* gnat.

NEWS AND NOTES

Excerpts from release from Federal Security Agency, Public Health Service, Communicable Disease Center, Atlanta, Georgia, November 15, 1951:

JOSEPH AUGUSTIN LEPRINCE, eminent sanitary engineer, was honored Thursday by the National Malaria Society, which presented to him its first Joseph Augustin LePrince Award, established in his honor to recognize "Outstanding Accomplishment in Malaria Control."

Mr. LePrince, who is 76 and lives in Memphis, Tenn., is best known for his work with Dr. William Crawford Gorgas in virtually freeing the Canal Zone of mosquitoes and thus making possible the building of the Panama Canal.

His latest honor, the Joseph Augustin LePrince Award, was presented at 12 noon Thursday at the 34th annual meeting of the National Malaria Society, at the Congress Hotel in Chicago. It consists of a check for $500 and a citation signed by Dr. Justin M. Andrews, President of the Society. Dr. Andrews, of Atlanta, is Deputy Officer in Charge, Communicable Disease Center, Public Health Service, Federal Security Agency.

Nelson H. Rector, of Atlanta, a long-time friend of Mr. LePrince and Senior Sanitary Engineer of the Communicable Disease Center, made the presentation. He called Mr. LePrince "an outstanding engineer, who has played a major role in wiping out the terrific toll taken by malaria, not only in Cuba, Panama, and the United States, but all over the world."

Mr. Rector stated that Mr. LePrince was the first person to control malaria by the control of adult mosquitoes. He related how, along one strategic section of the Canal Zone, Mr. LePrince hired small boys to capture mosquitoes each morning immediately after dawn. He reasoned that the chain of infection could be broken if mosquitoes which had feasted on infected blood the night before could be prevented from biting other human beings. Records show that the malaria rate in those barracks where mosquito catching or swatting was practiced was cut to one-fortieth of the rate in nearby uncontrolled barracks.

"General Gorgas and Mr. LePrince did not have an easy road in Panama," Mr. Rector said. "They were true pioneers, tireless, resourceful, inspired. The record shows, I am sorry to state, that some United States officials did not cooperate with them to the fullest extent. In evaluating their phenomenal results, we must give credit to our great President Theodore Roosevelt, who overruled subordinates and gave General Gorgas and Mr. LePrince sufficient authority to prosecute successfully their necessary, life-saving work."

Dr. Felix J. Underwood, Executive Officer, Mississippi State Board of Health, relates that Mr. LePrince, accompanied by General Gorgas and another officer in a canoe, made the first trip through the Panama Canal. The trip almost ended tragically, for a strong current swept them near a dynamite charge, the fuse of which already had been lit. When the explosion occurred, they were showered by rocks and gravel, but they escaped unhurt.

In 1914, after 10 years in the Canal Zone, where his final title had been Chief Sanitary Inspector, Mr. LePrince returned to the United States. In 1915 he became a commissioned officer in the U. S. Public Health Service. His book, "Mosquito Control in Panama," was published in 1916. During World War I he had charge of the malaria control program in and around 28 Army and Navy installations in the United States.

"He reduced malaria to one-half of one per cent what it had been in Southern camps in the Spanish-American War," according to Mr. Rector. "This remarkable job was performed with a bare minimum of trained personnel and with inadequate supplies and poorly designed equipment."

In 1923 he was director of yellow fever control in the Mexican oil field area. In 1927 he was director of American Red Cross malaria control activities in the Mississippi River flood area. Since 1935 he has been consultant in malaria control to the Tennessee Valley Authority.

Until his retirement from the U. S. Public Health Service in 1939, Mr. LePrince played an important role in the early malaria control programs which have succeeded in all but eradicating the disease from the continental United States. He rose to the rank of Sanitary Engineer Director (colonel) in the commissioned corps of the Public Health Service.

In 1950 he was awarded the Ross Medallion, named for Sir Ronald Ross, discoverer of the mode of transmission of malaria, by the London School of Tropical Medicine, for distinguished work in preventing malaria. Only two other persons have received this award.

In May 1951 he was made an honorary member of the American Mosquito Control Association.

The Joseph Augustin LePrince Award will be given, on occasion in the future, by the National Malaria Society or its successor. The cash award was made possible this year by the Michigan Chemical Company, of St. Louis, Michigan.

WHO ARRANGES DDT PURCHASE. To combat the increasing shortage of vital insecticides needed in health campaigns, the World Health Organization has made arrangements to purchase DDT in the United States on behalf of other member countries of WHO.

A notice has been circulated to all interested governments by Dr. Brock Chisholm, WHO's Di-

rector General, that the Organization has obtained general export licenses from the United States, covering a large group of health supplies. Under these general export licenses, priority for DDT exports may be obtained immediately upon application by WHO and the Pan American Sanitary Bureau, the Regional Office of WHO in the Americas.

A priority reservation of some 15 million pounds of DDT has been set aside by the U. S. government for health and agricultural purposes abroad. However, priority will be granted only to orders placed for delivery during the third and fourth quarters of the year, at a time when U. S. requirements are at their lowest. Member governments are urged to obtain their requirements in the U. S. market for shipment before the end of the year in order to obtain the best prices and avoid conflict with U. S. domestic needs.

It will be recalled that the Fourth World Health Assembly last May drew the attention of DDT-producing countries to the critical shortage of insecticides needed for public-health programmes and asked for action to alleviate this situation. It was pointed out that *anti-malaria projects* in hand in a number of countries *aimed at the protection of populations of no less than 450 million people,* and that any interruption in the supply of DDT would present a serious threat to their health.

The U. S. government's decision was taken following representations by the Pan American Sanitary Bureau and the World Health Organization, and with the vigorous support of the U. S. Public Health Service.—WHO Newsletter.

"THE LAMP IS LIT" (referring to the lamp of health) is the title of a booklet by Ritchie Calder, published by the World Health Organization. Some dramatic results of malaria control are described.

In a remote corner of Bengal, for instance, a WHO team, working with the Pakistan authorities, demonstrated malaria control in a heavily infected area in which were living 250,000 people. At the end of the year "no cases of malaria were found among children under one year of age," said the report. But it also added: "The district Agricultural Officer reported an increase of 543 pounds of rice per acre for the year." When the sickness vanished the people became stronger. Because they were stronger, they worked harder in their fields. And because they worked harder they got their fields to produce more food. Actually, in handling the summer and autumn rice-crops, Mr. Calder tells us, nine men were able to do ten men's work, put in shorter working hours and still get that food increase.

In Greece, following malaria control, these things happened in the once-malarious districts: The average gross income of the local families practically doubled: the area cultivated increased by well over half. And, because the campaign rid the country of other insect pests beside mosquitoes: Milk yield of the cows went up by as much as a fifth; the hens gave more eggs: typhoid and dysentery, being fly-borne diseases, were cut down.

A similar campaign in Ceylon had, by the end of one year, reduced the country's death rate from all causes (not only malaria) from 22 per thousand to 14.3.

THE CONCESSION SUPPLY COMPANY, 3916 Secor Road, Toledo 13, Ohio, should have been included in the list of manufacturers of mosquito traps in the September "News and Notes." Their advertisements appear in the September and December numbers of MOSQUITO NEWS.

THE WORLD HEALTH ORGANIZATION has recently published a monograph by Dr. E. J. Pampana which reports results of his extended studies on the use of residual insecticides in anti-malaria work. This is the first document based on statistical data to give a picture of the success of malaria control using residual insecticides on a world scale. The gradual regression of a very deadly endemic disease in some thirty countries is described.

FRED STUTZ, DIRECTOR, Dade County (Florida) Anti-Mosquito District, has noted that some AMCA members do not realize that when travelling to meetings at public expense, they can deduct the 15 per cent federal tax from transportation costs. This applies to both Pullman and coach travel. Forms may be obtained from the Collector of Internal Revenue. Ask for Tax Exemption Certificates. Such savings can be an important consideration to the man who watches the budget.—H. L. T.

LIEUTENANT COMMANDER KENNETH L. KNIGHT has finished his tour of duty in Cairo, Egypt, where he is being replaced as Head of the Entomology Department, U. S. Naval Medical Research Unit #3, University of Cairo, by Commander H. S. Hurlbut. Ken, with his family, visited in Bethesda, en route to his new assignment in Malaria and Mosquito Control Unit #1, Jacksonville, Fla.—H. L. T.

JACK JONES, an AMCA member at the National Institutes of Health in Bethesda, has reviewed in this issue a paper by Barney Travis. Jack is working on the effect of insecticides on *Anopheles quadrimaculatus,* with particular emphasis on the effect of DDT on the heart and defecation rates of the larvae. In addition, he is preparing a detailed histological atlas of the normal and treated specimens.—H. L. T.

F. W. EDWARDS' classic monograph on the classification of mosquitoes, "Diptera, Family Culicidae," Fasc. 194 of the Genera Insectorum (1932) can be obtained from Genera Insectorum,

Les Sapins, Quatre-Bras, Crainhem, Belgique. The price is about $8.00.

DR. C. Y. CHOW, formerly of Formosa, has just informed us that he has been appointed by the World Health Organization as entomologist, assigned to the South East Asia Region. His present address is: Prof. C. Y. Chow, Insect-borne Diseases Control Training Center, Kurunegala, Ceylon.—H. L. T.

MR. GEORGE B. VOGT, who was placed on active duty in the Public Health Service Reserve last summer, is now doing malaria control work in Burma. His address is STEM to Burma, % American Embassy, Rangoon, Burma.

NEW ORLEANS WAS SUBJECT to one of the worst mosquito infestations in its history last summer. The salt marshes were unusually dry during the early part of the summer so that large numbers of *Aedes sollicitans* eggs accumulated. Heavy rains and high temperatures later in the season led to rapid development, and southerly winds did the rest according to a story in *The New Orleans Item*, quoting Dr. Albert Miller of the Tulane Medical School. The city's two anti-insect trucks were unable to keep up with the storm.

BY PROCLAMATION of the Governor of Virginia, Walter Reed Day was celebrated in Gloucester County. Dr. Reed's birthplace, Belroi, near Gloucester Court House is one of several memorials to him. Mr. Norman S. Beaton, Superintendent of Mosquito Control Commissions on the Lower Peninsula of Virginia, was present at the exercises.

PYROLAN. *Mosquito Buzz* (California) reports briefly on the new insecticide, Pyrolan, which was discovered by the Swiss. It is not extremely toxic to warmblooded animals, and it appears to have little or no effect on insects with chewing mouthparts such as caterpillars, roaches and beetles. In some respects it is comparable to rotenone. Pyrolan has been effective when used against DDT-resistant flies, and the house fly does not seem to develop a resistance to it.

PRIMAQUINE. The Office of the Surgeon General, Department of the Army, has announced that all servicemen returning from Korea will receive the new antimalarial drug, primaquine. Doses of 15-milligrams for 14 consecutive days will follow a one gram dose of the malaria suppressant, chloroquine. Primaquine is said to be an effective therapeutic agent against malaria when the parasites have lodged in the liver or other body organs. It is therefore expected that the serviceman who has been exposed to malaria will be cured before an attack of malaria or before relapses of the disease can occur. Primaquine is not a preventive for malaria.

MR. W. H. W. KOMP of the National Institutes of Health is now in Costa Rica where he is serving as a consultant in yellow fever investigations for the Pan American Sanitary Bureau. Last summer cases of jungle yellow fever occurred in Costa Rica for the first time in many years. The outbreak is being watched very carefully as it could develop into a serious situation, according to the NIH Record.

Jungle yellow fever exists as an animal and human disease in the jungles. Persons going into the jungle can be protected by immunization. But an unprotected person coming out of the jungle with yellow fever virus in his blood can be the starting point of a dangerous outbreak any place where *Aedes aegypti* is found.

NEW JERSEY has had an unusual mosquito year. The lower half or South Jersey had below normal rainfall, and for the most part mosquito incidence was quite low. North Jersey on the other hand had above normal rainfall with the result that there were more mosquitoes than have been present for the past few seasons. The precipitation at Fortesque on the Delaware Bay was .83 inches in July, while at Belvidere in North Jersey it was 10.59 inches. These were extremes, but the general averages showed about 2 inches for the south while the north got 5 inches. August was hot and humid, and mosquitoes prospered. Middlesex County was confronted with a serious problem resulting from a large hydraulic fill. There were deep cracks at angles so that water could not be seen. The mosquitoes were so bad that you "couldn't get your breath."

The labor situation was extremely annoying. Few college students were available. They wanted more money, and then when they had earned $499.00 they quit so that "Daddy would still have an exemption." Contractors will pay up to $2.25 per hour for a good shovel or sprayer man. (Most of the above was contributed by George E. Powers of Union County.)

CULICIDOLOGY. There are at least two formal courses devoted exclusively to the study of mosquitoes in American universities. Both of these are for graduate students. Dr. Osmond P. Breland had six students in his course at the University of Texas in the fall of 1950, and we had eight in our course at the University of Maryland in the spring of 1951.

Dr. Breland's course is called "Biology and Taxonomy of the Culicidae." Laboratory periods were frequently devoted to field trips emphasizing larval collecting, the collection of adults "attracted to our bodies" and the collection and subsequent flooding of dry matter in the laboratory. Other laboratory time was spent in identification of specimens, mounting larvae and adults and a study of identification by male genitalia. Lecture periods included discussions and reports on such subjects as new insecticides and repellents, speciation in mosquitoes, the use of female

genitalia for classification, and general mosquito biology. No specific textbook was followed.

At Maryland the course is called "Bionomics of Mosquitoes." The laboratory work was heavily systematic. We observed various types of breeding areas on field trips, and had an interesting visit to the Patuxent River Naval Air Station where Mr. Thomas M. Gunn demonstrated control methods. Bates' "Natural History of Mosquitoes" was studied rather intensively. Matheson's "Mosquitoes of North America" was also used.—W. E. B.

FLORIDA NOTE FROM H. L. T. I was in Miami during the latter part of August and had the pleasure of looking over Dade County's mosquito-fighting equipment and meeting its personnel, under the direction of Fred Stutz.

Later, we drove for several hours over the area under control, and I realized the vastness and complexity of such a project. There are included in the County about 10,000 square miles of uninhabited marshlands, plus the Everglades, Miami, Miami Beach, Coral Gables, and numerous other communities. Fred believes that the unprecedented numbers of *Aedes taeniorhynchus*, the species then on the warpath, were due to the unusually dry weather which stranded and killed thousands of fish which ordinarily would have eaten the mosquito larvae. This species reputedly has an especially irritating and lasting bite. During my visit, I learned, too, that the lighthouses off the Keys have screens to protect the occupants against heavy flights of mosquitoes.

Another day, Fred Stutz, John Porter of the U. S. Public Health Service Quarantine Station at Miami, and I visited the Sandfly Laboratory at Ft. Lauderdale. This work is being conducted under the auspices of the Florida State Board of Health, Dade, Broward, Indian River and Palm Beach Counties, and the scientific direction of the U. S. Dept. of Agriculture at Orlando. Robert Goulding is in charge of the project, which includes studies on the effectiveness of the new organics, such as chlordane and dieldrin. *Culicoides furens* is the species of immediate primary interest. We met James H. Bertholf, Director of the Broward County Anti-Mosquito District, and Mr. Goulding's associates, Jerry LeBreque and Robert Currans.

While in Miami, I stopped for a short time at the South Campus of the University of Miami, where I enjoyed a visit with Dr. and Mrs. Donald C. A. Butts. Dr. Butts, another AMCA member, is teaching at the University and also directing some research investigations on malaria, mosquitoes, and insecticides.—H. L. T.

IN JUNE 1950, at an informal meeting of malariologists and medical entomologists, held at Delhi, India, a national society of workers on malaria and other mosquito-borne diseases was formed. A proposal was made to publish a bulletin as an official organ of the society. This bulletin will be published on the model of MOSQUITO NEWS and we shall look forward to sending it to the Board of Editors of the latter publication early in January, 1952.—Rajindar Pal.

DR. RAJINDAR PAL, Assistant Director of the Malaria Institute of India, came over to the United States recently to participate in the Expert Committee on Insecticides of the World Health Organization. The Committee has drawn up specifications of spraying equipment used in malaria control work and it is hoped the report will receive wide circulation to the purchasers and manufacturers in order to stimulate production of first rate equipment.

An indispensable item for all mosquito control workers and commissioners, libraries, schools, park and playground officers, and public officials. See Page V.

AMCA 1952 CONVENTION

The annual convention of the American Mosquito Control Association will be held jointly with the Utah Mosquito Abatement Association in the Hotel Utah, Salt Lake City, March 24, 25, 26, and 27, 1952. All parts of the United States, Canada, and Central and South America will be represented at the convention, and all interested in the biology and control of mosquitoes are invited to attend.

An outstanding program of wide interest covering research and development in mosquito control is being arranged. The deadline date for receiving titles of additional papers is January 26, 1952. They should be sent to the chairman of the program committee, Dr. C. R. Twinn, Division of Entomology, Department of Agriculture, Ottawa, Canada, accompanied by an abstract of not more than 200 words for publicity purposes and incorporation in a summary of the proceedings.

The business of social arrangements for the Convention are being taken care of by local committees appointed by the Utah Mosquito Abatement Association, who will act as hosts. Registration of members and guests will commence on March 24 at 2 P.M. in the Hotel Utah. Hospitality Hour is at 8 P.M. of the same day, followed by an informal showing of kodachrome slides and movies. Other social events will include a field trip and tour of Salt Lake City on the afternoon of March 26, followed by a banquet in the evening. A special program of entertainment has been arranged for the ladies.

The first session for papers and discussion is at 9 A.M., March 25. The program for this session is being organized by the Utah Mosquito Abatement Association, and will include addresses by Dr. F. C. Bishopp, Dr. Bailey B. Pepper, and several other prominent speakers. Other sessions will be held on the afternoon and evening of March 25, and the mornings of March 26 and March 27.

Progress will be reported in mosquito biology and control work throughout the Americas, and developments in mosquito eradication in various other parts of the world. Improved fogging and spraying apparatus for use on the ground, and equipment for spraying from the air, will be described. Mosquito control equipment will be exhibited and given field demonstrations.

The use of the newer insecticides, such as aldrin and dieldrin, against mosquitoes and other annoying Diptera will be reviewed. Among other subjects to be discussed at the convention are the effectiveness of insecticide residues and mist sprays in controlling adult mosquitoes; the status of mosquito resistance to insecticides; the use of radioactive tracers in assessing the effectiveness of insecticides sprayed from aircraft; mosquitoes as vectors of disease and measures taken to combat them in Korea, Africa, Panama, and elsewhere; the relation of agricultural practices and water development programs to mosquito control; new methods of locating mosquito eggs in soil, and of making accurate counts of mosquito larvae; progress in flight range studies; control of biting gnats; non-human malaria, and other subjects of equal interest.

AMCA members have already received an attractive folder describing some of the entertainment features arranged for the AMCA convention, mentioning that several "extra curricular" activities have been arranged. These will include an informal showing of colored slides and motion pictures, including pictures taken by Dr. Bishopp in Europe during the past summer; tours of the State Capitol and other places of interest in the city and vicinity; an organ recital at the Mormon Tabernacle; a tour of the University campus; visits to mining operations; and other points of interest.

Plan to attend the Annual Convention now, and make your reservations at the Hotel Utah without delay.

REVIEWS AND ABSTRACTS

Area Control of Mosquitoes by Aircraft in Sub-Arctic Canada. By C. R. Twinn, A. W. A. Brown and H. Hurtig. N. J. Mosquito Extermination Assn. Proceedings, 1950. Pp. 113–140. This article presents the results of experimental air spray projects carried out cooperatively by the Division of Entomology, Science Service, Department of Agriculture, Canada, the Defence Research Board and the Royal Canadian Air Force. Spray projects were conducted at five R.C.A.F. stations, namely: Fort St. John and Ft. Nelson in British Columbia; Whitehorse and Watson Lake in Yukon Territory and Goose Bay in Labrador.

About 10 square miles around each of these stations were sprayed, some of them twice, with a dosage of about 0.25 lb. DDT per acre. The first treatment was larvicidal and the second adulticidal. A total of 27,600 acres were treated with 19,159 gallons of 4 per cent DDT fuel oil solution. The average application was 0.7 gallon of spray with 0.235 lb. of DDT per acre. The average larval mortality ranged from 83 per cent to 99 per cent with the overall average being 91 per cent. The larviciding resulted in a significant reduction of adult mosquitoes for two weeks to as much as two months from the date of spraying. In two areas there were indications that the larviciding reduced the adult population by approximately 50 per cent throughout the season. Adulticiding resulted in an immediate reduction of 86 per cent in mosquito numbers at Ft. Nelson, B. C., and Watson Lake, Y. T., and a 65 per cent reduction for three weeks at Watson Lake.

The report includes information on apparatus and materials, methods, operational data, assessments of DDT deposits and effects of spraying on other insects. It is well illustrated with pictures, maps, charts and graphs. Of particular interest are the graphs of mosquito landing rates and biting rates in sprayed and unsprayed areas.—Edgar A. Smith, Merced Co. M.A.D., Merced, Calif.

Further Tests of Insecticides Against Black Flies (Diptera: Simuliidae) and a Control Procedure. By B. Hocking. Scientific Agriculture 30:489–508. 1950. This paper is of interest to mosquito workers chiefly in the presentation of information on the toxicity of the newer insecticides to the fauna of streams, showing that all materials tested kill some beneficial insects and fish. The insecticide dispensor described in the appendix might have application in some places in mosquito work. The author summarizes the paper as follows:

"Various formulations of DDT, parathion, gamma benzene hexachloride, methoxychlor, aldrin, dieldrin, and 1, 2, 4-trichlorobenzene were tested in the field for toxicity to the larvae and pupae of several species of black flies (Simuliidae). Laboratory tests of parathion suspension and benzene hexachloride emulsion showed that these materials have some ovicidal properties. Against larvae, DDT in oil solution is still by far the most satisfactory insecticide. Parathion; benzene hexachloride; aldrin; and trichlorobenzene at high concentrations show some toxicity to pupae, but the practical value of this and of the ovicidal materials is doubted.

"DDT, benzene hexachloride, and parathion were tested on the fry and adults of several species of fish. The absence of any immediate permanent effects at the dosages required to kill black fly larvae is encouraging.

"Observations on the effects of all insecticides except DDT on other fauna in the streams treated are recorded. The results do not suggest that the toxicity of any of the materials is more selective to black fly larvae than that of DDT.

"A dispenser for the convenient and accurate application of insecticides to streams is described in an appendix, and simplified instructions for its use are given."—Elton J. Hansens, Rutgers University, New Brunswick, New Jersey.

Egg-laying Habits, Overwintering Stages, and Life-cycle of *Simulium arcticum* Mall. (Diptera: Simuliidae). By F. J. H. Fredeen, J. G. Rempel, and A. P. Arnason. The Canadian Entomologist 83(3), March 1951. Studies conducted along the Saskatchewan River from 1947 to 1950 indicate that *Simulium arcticum* Mall. oviposits generally over the surface of the river water during July. The eggs are laid singly, sink to the bottom, and may become embedded several inches in the sand. The species overwinters almost entirely in the egg stage. The eggs begin to hatch in the spring soon after the ice clears from the river, and the larvae move downstream and attach themselves to rocks in rapids to complete their development. The control of this black fly may require repeated applications of larvicide because of a long hatching period.—Authors' summary.

Effectiveness of Repellents Against Several Species of *Anopheles* Mosquitoes. B. V. Travis, Jour. Nat. Malaria Soc. 10(3):197–205. 1951. Out of 4,313 compounds screen tested for repellence of *Anopheles quadrimaculatus* only the following four materials were effective for as long as three hours when laboratory tested: p-isopropoxybenzaldehyde, alpha-amylcinnamaldehyde, methyl beta-diethylaminocrotonate, and N-amylsuccinimide. The latter substance was also effective against *gambiae melas*. Attempts to incorporate the test materials into unspecified creams and powder pastes were not encouraging.

Forty-nine materials were tested for repellence against *freeborni*, eight of which were effective for more than seven hours. Five of the 12 materials screen tested against *punctipennis* were effective for more than seven hours. It is not possible from the data presented, however, to compare effective test repellents against the different species used since most of the test repellents effective against *quadrimaculatus* were not tested against the other species, nor were repellents against *freeborni* and *punctipennis* tested against *quadrimaculatus*.

Field tests on the repellency of dimethyl phthalate, Indalone, and 6-12 against *albimanus, gambiae,* and *aquasalis* are reported. Dimethyl phthalate lost its repellency for *albimanus* in 40–60 minutes in laboratory tests, and in the field was effective for the first hour. Its average repellency for *gambiae* was 45 minutes, and for *aquasalis* 2½ hours. The repellent 6-12 was effective 8–100 minutes against *albimanus* in the laboratory, and had a field repellence of 2–3 hours. Against *gambiae* its average repellency was 20 minutes. Against *aquasalis* 6-12 was the most effective repellent with an average repellency of 2½ hours. Indalone was not very effective against *albimanus* or *gambiae*. However, it was effective against *aquasalis* for 2½ hours and was better than no treatment after 8 hours.—Jack Colvard Jones, National Institutes of Health, Bethesda, Md.

SUMMARY OF THE SIXTEENTH ANNUAL REPORT—DADE COUNTY ANTI-MOSQUITO DISTRICT, 1950. 16 pp. Fred H. Stutz, Director; James H. Heidt, Entomologist, Rm. 905 Dade County Court House, Miami, Fla. The report contains some information on the behavior of salt marsh mosquitoes which seem to be Dade County's greatest problem. For three years there were noticeably fewer mosquitoes until 1949–50, when there were frequent heavy flights, which has caused the Commission to wonder if they were becoming immune to DDT. Observations show that excessive dry periods are followed, with few exceptions, by an increase in mosquitoe densities.

Aedes aegypti control continues unremittingly, although inoculation of travellers and the surveillance of the U. S. Public Health Service, particularly at the International Airport, is being depended upon for protection against the introduction of disease.

Dade County has a very perplexing problem with year-round mosquito breeding but it is handling the job in a very efficient and economical manner, which is shown by the listed routine of work, the inspections, the description of plant and equipment, and expenditures.

The district mixes a 35 per cent DDT-emulsion concentrate for a stock insecticide. A dilute concentrate of 2½ per cent DDT-emulsion is used in mist sprayers as an adulticide or larvicide. Ground-space spraying, operating three mist sprayers at a cost of $.146 per acre, was employed.

Airplane spraying was utilized for the salt marsh area to control numerous flights of *Aedes taenior nynchus* and also for *Psorophora confinnis*. In addition to 5 per cent DDT-oil, benzene hexachloride, mixed directly in fuel oil, .1 lb. of gamma per gallon, was employed, very good results being obtained by both mixtures.

Drainage is being systematically carried out, but hydraulically filled land for development is presenting problems. Inspection of premises, some space spraying in certain districts of Miami, and collection of small containers are routine. Street catch basins are sprayed by a motorcycle operator to control Culex mosquitoes.

Light traps are employed, with *Anopheles albimanus* showing up, the presence of this malaria vector is causing much alarm.

Fly control is part of the County routine.

Mention is also made of the cooperative sand fly research work by the Division of Entomology of the Florida State Board of Health, with technical direction by the Orlando Laboratory of the U. S. Bureau of Entomology. During 1950 control tests on small plots were conducted, using three of the newer insecticides, Chlordane, Hexachloride and Dieldrin, with excellent results. Tests will continue to determine the most effective materials, dosages, formulations and methods of applications. More basic information on the insects is also desired.—J. S. Gibson, Warwick County, Virginia.

PUPAE OF THE CULICINE MOSQUITOES OF THE NORTHEASTERN UNITED STATES (DIPTERA, CULICIDAE, CULICINI). Richard F. Darie, Jr. Memoir 304, Cornell University, Agricultural Experiment Station, June 1951. The pupae of 32 species are described, 8 of which have not been studied previously. The abdominal chaetotaxy, paddles, and respiratory trumpets are illustrated. A brief discussion is given on the external morphology of the pupal exuvium, adequate for understanding the descriptions.

In instances where earlier pupal work has been done on a species, references are cited by the author. The bibliography includes 51 titles. Tables of variations in setal branching are given for each species. Keys to the genera and all 32 species, as well as to the subgenera of *Aedes,* are included.

The author is to be complimented on his thorough observations, the publishing of which will go far toward enlightening American workers on the taxonomic characters to be found on the mosquito pupa. This paper is the first in this country to bring together and describe adequately a regional group of culicine pupae so that characters can be compared and keys for identification devised.

It is the reviewer's opinion, however, that the paper could have been improved by an analysis of the significance of the characters. The reader is apt to be misled by the keys, as Darsie fails to stress that many of his series of specimens

were small and from single collections. In some instances, from series of fewer than 20 specimens, species are separated on the basis of a slight difference in range of hair branches.

The tables of variations in setal branching should include the number of specimens under observation and the number of separate collections these specimens represent. If only a single series from a single breeding place is examined, less variation is to be expected than from several series from different localities.

Proof of the reliability of Darsie's keys will be tested through their use by many workers, some of whom probably will be able to make suggestions for improvement on the basis of their own experience. It is hoped that those in a position to do so will take advantage of the start that Darsie's study has given them in understanding the culicine pupa and using it in the taxonomy of the group.—Roy W. Chamberlain, U. S. Public Health Service, Montgomery, Ala.

STUDIES ON THE SWARMING HABITS OF MOSQUITOES AND OTHER NEMATOCERA. E. T. Nielsen and H. Greve. Bull. Ent. Res. 41(2):227–258. Sept. 1950. The principal object of this work was to elucidate the swarming behavior of *Aedes cantans* and other mosquitoes, *Chaoborus crystallinus* and certain Chironomids. In addition, ancillary studies were made of the general ecology of these species. The swarms were found to consist entirely of males and to bear no direct relationship to mating or to the search for food. There was no noticeable difference between the swarming habits of the different species of mosquitoes and even the differences between the Culicids and Chironomids were very slight. Swarming was observed to take place at about sunset in the evening and sunrise in the morning. The evening swarms appeared to be formed in response to decreasing light intensity and to disperse at a light intensity of about 7 Lux. Low temperatures may delay the start of swarming. The morning swarms started at about the same threshold of light intensity and at this time also their duration was reduced by low temperatures. Below about 50° F. they were not formed at all. Atmospheric humidity appeared to be of minor importance.—Authors' summary.

(Editor's note: The work described above was done from 1938–40 and from 1945–48 in Northern Denmark.)

LOS MOSQUITOS DEL GENERO *Haemagogus* WILLISTON 1896 EN AMERICA DEL SUR. Roberto Levi-Castillo, published by Don Bosco, Cuenca, Ecuador, 1951, 78 pp., 114 refs. The mosquitoes of the genus *Haemagogus* are described. A new subgenus, *H. longipalpifer* is described. The species having short palpi, *H. panarchys, H. equinus* and *H. tropicalis* remain in the original subgenus, *Haemagogus* Williston 1896. Thirteen species and 1 subspecies are described in all known phases of their life cycle. The larvae of *H. uriartei* Shannon and Del Ponte are described for the first time. Keys are included for male terminalia and the known larvae of the species. Notes on the ecology and breeding places are included. A distribution map of the species is also given. All known references are included.—Author's abstract.

Editor's Note: Apparently there is considerable interest in the genus *Haemagogus,* to judge from correspondence reaching the editorial office regarding Dr. Levi-Castillo's monograph. It is noted that there is some disagreement with Dr. Levi-Castillo's position on certain points. Some authorities feel that the keys are difficult to follow, and at critical points are based on characters that are not constant. Since disagreement among taxonomists is not unusual, these criticisms are mentioned herewith so that others will be aware of some of the differences of opinion on the treatment of *Haemagogus.*

Turn back to Page 224 for information on the AMCA 1952 convention.

REFERENCES TO LITERATURE OF INTEREST TO MOSQUITO CONTROL WORKERS AND MALARIOLOGISTS

H. H. STAGE AND HELEN SOLLERS

United States Department of Agriculture, Bureau of Entomology and Plant Quarantine, Washington 25, D. C.

AERIAL APPLICATION

DEPARTMENT OF THE AIR FORCE. 1951. Aerial dispersal of insecticides. Department of the Air Force AFM 90-4, 37 pp., 20 refs.

MARKOS, B. G. 1951. Distribution and control of mosquitoes in rice fields in Stanislaus County, California. Natl. Malaria Soc. Jour. 10(3):233–247, 10 refs.

YUILL, J. S., AND EATON, C. B. 1951. Airplane spraying for forest pest control. U. S. Bur. Ent. and Plant Quar. E-823, 21 pp.

AEROSOLS

FALES, J. H., NELSON, R. H., FULTON, R. A., AND BODENSTEIN, O. F. 1951. Tests with two insecticidal aerosols for use on aircraft. Jour. Econ. Ent. 44(4):621–622, 4 refs.

FULTON, R. A., NELSON, R. H., AND YEOMANS, A. H. 1951. Evaluation of liquefied gas aerosols. Soap and Sanit. Chem. 27(8):129–131, 7 refs.

SHERMAN, R. W. 1951. Insect control on aircraft. Soap and Sanit. Chem. 27(8):122–127, 8 refs.

LARVICIDES

BERNET, —. 1950. Utilisation des solutions de pyrethrines dans la lutte contre les larves d'*Anopheles*. Med. Trop. 10(3):558–563.

BERTRAM, D. M. 1950. Larvicidal treatments with DDT and gammexane in Upper Assam, with particular reference to their effect on *Anopheles minimus*. Ann. Trop. Med. and Parasitol. 44(3): 255–259.

POTANOV, A. G. 1951. Znachemie novoi sistemy orosheniia sel' skokhoziaistvennykh zemel' dlia profilaktiki maliarii. Gesundheit und Wohlfahrt 31(2):42–44.

RACHOU, R. G., AND DE MELLO, P. J. 1950. Uma prova experimental de aplicacao de larvicida por aviao em um braco morto do Rio Iguacu, em Sao Bento. Rev. Brasileira Malariol. 2(4): 339–344.

ROMAN, E., AND RINAUDO, E. 1951. Action sur les larves du moustique citadin des esters phosphoriques organiques. Jour. Med. de Bordeaux 128(1):256–257.

TRAPIDO, H. 1951. The toxicity of DDT to *Anopheles claviger* (Meigen) in Sardinia and on the Italian mainland. Natl. Malaria Soc. Jour. 10(3):266–271, 10 refs.

WHITEHEAD, F. E. 1951. Rice field mosquito control by pellet-borne insecticides. Ark. Agr. Expt. Sta. Bul. 511, 30 pp., 8 refs.

ADULTICIDES

ALVES, W. 1951. Preliminary note on a Southern Rhodesian experiment in malaria control. So. African Jour. Sci. 47(10):289–292, 3 refs.

BERNARD, P. 1950. Malaria control with contact insecticides in Madagascar. Soc. de Path. Exot. Bul. 43 (7/8):505–512.

DOWNS, W. G. AND BORDAS, E. 1951. Control of *Anopheles pseudopunctipennis* in Mexico with DDT residual sprays applied in buildings. Part V. Effectiveness of residual applications of DDT and gammexane up to one year after application under controlled conditions. Amer. Jour. Hyg. 54(1): 150–156, 25 refs.

DOWNS, W. G., BORDAS, E., AND NAVARRO, L. 1951. Duration of action of residual DDT deposits on adobe surfaces. Science 114(2958): 259–262, 19 refs.

HADAWAY, A. B., AND BARLOW, F. 1951. Studies on aqueous suspensions of insecticides. Bul. Ent. Res. 41(3):603–622, 18 refs.

LOZANO MORALES, A., AND JUAREZ JUAREZ, E. 1950. E consideraciones sobre una campana de pulverizaciones residuales de la zone paludica del rio Tietar (Caceres). Rev. de Sanid. e Hig. Pub. 24(11/12):803–816.

MACDONALD, G. 1950. Residual insecticides in Assam. [Correspondence] Brit. Med. Jour. 4675: 414.

PAMPANA, E. J. 1951. Lutte antipaludique par les insecticides a action remanente; resultats des grandes campagnes. World Health Organ. Bul. 3(3):557–619.

RACHOU, R. G., AND LIMA, M. M. 1951. Da aplicacao de DDT apenas em faixas pintadas nas paredes internas das cassas, em zona de transmissao de malaria por anofelinos do sub-genero *"Kerteszia"*: primeiras provas experimentais. Rev. Brasil. Malariol. 3(1):36–47.

RAMACHANDRA RAO, T. 1951. Malaria control using indoor residual sprays in the Eastern Province of Afghanistan. World Health Organ. Bul. 3(3):639–661.

SABATINI, A. 1951. La lotta antianofelica nell 'Agro Romano negli anni 1947–1950. Riv. di Parassitol. 12(3):185–192.

SERRANO, M. B., AND DE GUIA, F. 1950. Residual DDT against *Culex fatigans:* preliminary reports. Monthly Bul. Bur. Health, Manila 26(2): 67–73, 4 refs.

WHARTON, R. H. 1951. DDT and BHC as residual insecticides in Malaya. Nature [London] 167(4256):854–855.

GENERAL CONTROL MEASURES

ANONYMOUS 1951. WHO malaria team finishes work in Pakistan, new campaign in the Lebanon. Egypt. Med. Assoc. Jour. 34(2):159–160.

ARAGAO, M. B. 1950. Nota preliminar sobre a accao bromelicida de alguns compostos de cobre insoluveis n'agua. Rev. Brasil. de Med. 7(12): 788–790.

BEKLEMISHEV, V. N. 1950. Evaluation of the efficacy of methods in application of DDT against mosquitoes in control of malaria. Gigiena i sanitariia [Moskva] 12:32–33.

CHAKRABORTI, S. K. 1951. Fish culture and malaria control. Co-op. & Marktg. Rev. 5(1):21–25.

CHOZA FERRER, J. A., AND PINERO CARRILLO, J. F. 1950. Diez anos de lucha antipaludica. Rev. Clin. Espanola 38(3):199–201.

EJERCITO, A. 1950. Malaria control work and the men behind it. Monthly Bul. Bur. Health, Manila 26(2):27–29.

———— 1950. Simplified, handy and economical construction of an automatic siphon sluice for the control of stream-breeding *Anopheles*, vector of malaria (Design IV). Monthly Bul. Bur. Health, Manila 26(2):31–42, 8 refs.

———— 1950. Expanding malaria control activities in the Philippines. Monthly Bul. Bur. Health, Manila 26(2):63–66.

FARID, M. A. 1951. Malaria control. Libanais Med. Jour. 4(1):16–23.

FERREIRA, M. O., RACHOU, R. G., AND LIMA, M. M. 1951. Consideracoes sobre o combate ao *Anopheles (Kerteszia) cruzii* em Caldas da Imperatriz (S. Catarina) pelo desmatamento; abrigos naturais dessa especie. Rev. Brasil. Malariol. 3(1): 14–35.

GARDINER, R. C. 1950. Mosquito control at Rosemere. Quebec Soc. Protect. Plants Rpt. 31: 36–40.

GIMENO, DE SANDE, A. 1950. Campana profilactica antipaludica con gammaexano en motril, durante el ano 1949. Rev. de Sanid. e Hig. Pub. [Madrid] 24(9):651–658.

GUTIERREZ, J. F., NEGHME, A. R., AND ALBI DE LA FUENTE, H. 1950. Estado actual del control del Anofelismo en Chile. Rev. Chilena Hig. y Med. Prev. 12(3/4):67–71, 3 refs.

LIVIDAS, G. 1951. Malaria control in Greece during the last fifty year period. Riv. di Malariol. 30(1):17–27.

MUNRO, J. A. AND POST, R. L. 1951. The cost and effectiveness of a mosquito control program and its effect upon other forms of life. Amer. Assoc. Econ. Ent. Proc. 6th Ann. Meeting North Central States Branch, pp. 21–23.

NAIR, C. P. 1951. Studies on DDT barrier spray with reference to local rainfall and seasonal incidence of mosquitoes. Roy. Soc. Trop. Med. and Hyg. 44(6):741–746, 6 refs.

PASSAGER, ——. 1951. Essais d'eradication du paludisme dans une oasis du sud algerien. Techn. Hosp. Sanit. et Soc. 6(66):31–38.

PEPPER, B. B. 1951. Where are we in mosquito control. N. J. Dept. Health. Pub. Health News 32(1):9.

PINOTTI, M. 1951. The biological basis for the campaign against the malaria vectors of Brazil. Roy. Soc. Trop. Med. and Hyg. Trans. 44(6):663–682, 11 refs.

POTAPOV, A. G. 1950. New system of irrigation and control of malaria. Feldsher i Akusherka 11:31–32.

RACHOU, R. G. 1951. Erradicaco de anofelinos transmissores de malaria. 1. Consideracoes gerais. Rev. Brasil. Malariol. 3(1):92–100.

————, FERREIRA, M. O., AND LIMA, M. M. 1950. O sulfato de cobre como bromelicida; sua primeira aplicacao em Santa Catarina (Brasil); resultados preliminares. Rev. Brasil. Malariol. 2(4):306–317.

SUFFOLK COUNTY, N. Y. 1951. Mosquito Control Commission Report, 15 pp.

VARGAS, L. 1950. Insecticidas modernos en la lucha contra el paludismo. Gaceta Med. de Mexico 80(3/4):352–373.

VISWANATHAN, D. K. 1950. Malaria and its control in Bombay State. 263 pp. Poona.

WILSON, C. S. 1951. Control of Alaskan Biting Insects. U. S. Pub. Health Rpts. 66(29): 917–922, 5 refs.

See also Bur. Vector Con. under Biol. and Ecol.

REPELLENTS

RACHINSKII, F., PERVOMAISKII, G. S., AND CHAGIN, K. P. 1951. Dimethyl phthalate as means of protection from gnats. Zool. Zhur. 30(1):69–72.

SMITH, C. N., AND COLE, M. M. 1951. Mosquito repellents for application to clothing. Natl. Malaria Soc. Jour. 10(3):206–212.

TRAVIS, B. V. 1951. Effectiveness of repellents against several species of *Anopheles* mosquitoes. Natl. Malaria Soc. Jour. 10(3):197–205.

TOXICITY TO BENEFICIAL FORMS OF LIFE

GOMEZ, H. A. 1951. Inocuidad de la adicion al aqua potable de 1 p.p.m. of DDT para la erradicacion del *Aedes aegypti*. Bol. de la Of. San. Panamer. 30(3):330–337.

See also Munro, et al. under General Control.

TAXONOMY

BREELAND, S. G. 1951. The identification of the early larval instars of three common anophelines of Southern Georgia, USA. Natl. Malaria Soc. Jour. 10(3):224–232, 13 refs.

CORREA, R. R. 1950. Des cricao de *Anopheles (Kerteszia) montemor* nova especie de anofelino do Brasil (Diptera, Culicidae). Arq. de Hig. e Saude Pub. 14(39/42):53–55.

GAUD, J., AND LAURENT, J., 1950. Les soies doublees chez les larves d' *Anopheles*. Ann. de Parasitol. Humaine et Compar. 25(5/6):480–484.

KNIGHT, K. L., AND HULL, W. B. 1951. The *Aedes* mosquitoes of the Philippine Islands. I. Keys to species. Subgenera *Mucidus, Ochlerotatus*, and *Finlaya* (Diptera, Culicidae). Pacific Sci. 5 (3):211–251.

LAVEN, H. 1950. Der schuppenindex als unterscheidungsmerkmal der arten in der *Anopheles maculipennis* gruppe. Ztschr. f. Tropenmed. u. Parasit. 2(1):111–124, 18 refs.

REMOTTI, E. 1950. Forme macro- e micro-adeniche in *Anopheles maculipennis*. Soc. Itali di Biol. Sper. 28(6):1314–1316.

SASA, M. 1949. Redescription of *Aedes nobukonis* Yamada, 1932, with designation of its subgenus. Jap. Jour. Expt. Med. 20(3):409–411.

SOMEREN, E. C. C. VAN. 1951. New culicini from Kenya and Uganda. Roy. Ent. Soc. London, Proc. Ser. B: Taxonomy 20(1/2):1–9.

TREMBLEY, H. L. 1951. Pyloric spines in mosquitoes. Natl. Malaria Soc. Jour. 10(3):213–215, 5 refs.

BIOLOGY AND ECOLOGY

ANONYMOUS. 1951. The mosquito and its prey. Brit. Med. Jour. 4715:1131, 8 refs.

BERNET, —. 1950. Les heures d'agressivite du *A. gambiae* en A.O.F. Med. Trop. 10(3):564–565.

BRUCE-CHWATT, L. J., AND FITZ-JOHN, R. A. 1951. Mosquitoes in crab-burrows on the Coast of West Africa and their control. Jour. Trop. Med. and Hyg. 54(6):116–121, 12 refs.

BUREAU OF VECTOR CONTROL. 1951. Mosquito abatement in California. Calif. Dept. Pub. Health, Bur. Vector Control, Bul. No. VC-1, 47 pp.

BUSTAMENTE, F. M., DE, AND GUEDES, A. S. 1950. Armadilha "Dawn Trap" de Shannon. Do seu emprego para a captura do *A. (N.) darlingi* em Engenheiro Dolabela, Minas Gerais. Rev. Brasileira Malariol. 2(4):326–327.

BUSTAMENTE, F. M., DE, AND COWORKERS. 1951. Sobre a captura do *Anopheles darlingi* e do *Anopheles albitarsis* nas paredes externas de casas dedetizadas em Engenheiro Dolabela, Minas Gerais. Rev. Brasil. Malariol. 3(1):122–129.

COLLINGTON, E. 1951. Comportement des *Anopheles* dans le Departement d'Alger, en 1950. Inst. Pasteur d'Algerie. Arch. 29(1):25–27.

CORREA, R. R. 1950. Alguns informes sobre *Anopheles (Aribalzagia) intermedius* (Chagas, 1908), (Diptera, Culicidae). Arq. de Hig. e Saude Pub. 14(39/42):79–83.

———— AND OLIVEIRA LIMA, F. DE. 1951. Antropofilia do *Anopheles albitarsis domesticus* do *Anopheles darlingi* e do *Culex fatigans*. An. Paul. de Med. e Cirurg. 61(1):38–40.

EICHLER, W. 1950. Indikationsstellung und terminfestsetzung zur flugzeugstaubung in der malariabekampfung. Internatl. Cong. Ent. Proc. 8:850–855.

———— 1950. Salzwasservertaglichkeit und sommerphase des *Anopheles atroparvus*. Internatl. Cong. Ent. Proc. 8:856–859.

———— 1951. Anopheles—beobachtungen in Sudrussland. Riv. di Malariol. 30(1):29–38.

EJERCITO, A., AND URBINO, C. M. 1951. Flight range of gravid and newly emerged *Anopheles*. World Health Organ. Bul. 3(4):673–682.

FLETCHER, T. E. 1951. Estimation of traces of DDT using *Aedes aegypti* larvae as a biological indicator. Roy. Soc. Trop. Med. and Hyg. 44 (4):364–365.

GALINDO, P., TRAPIDO, H., AND CARPENTER, S. J. 1951. Studies on forest mosquitoes. Ann. Rpt. Gorgas Mem. Lab., 1950, pp. 12–17.

HELL, J. C. VAN. 1950. Iets over de anophelinen fauna van zuid-Celebes met vermelding van de malariaoverbrengsters in dit gebied. Med. Maandblad 3(11):379–394.

———— 1950. The significance of *A. (A.) hyrcanus* var. X as a malaria vector in South Celebes. Med. Maandblad 3(12):557–567.

JENKINS, D. W. 1950. Determining mosquito flight range with radioisotopes. Med. Div. Res. Rpt. (Army Chem. Center, Md.) No. 26, 9 pp.

———— AND HASSETT, C. C. 1951. Dispersal and flight range of subarctic mosquitoes marked with radiophosphorus. Army Chem. Center, Md., Med. Div. Res. Rpt. 44, 17 pp. Also in Canad. Jour. Zool. 29(3):178–187.

JETTMAR, H. M. 1951. Uber die resistenz der aquatischen entwicklungsformen der stechmucken gegen trocknung. Arch. f. Hyg. u. Bakt. 134(1): 11–26.

MCARTHUR, J. 1951. The importance of *Anopheles leucosphyrus*. Roy. Soc. Trop. Med. and Hyg. Trans. 44(6):683–694, many refs.

RAMSAY, J. A. 1951. Osmotic regulation in mosquito larvae; the role of the malpighian tubules. Jour. Expt. Biol. 28(1):62–73.

REEVES, W. C. 1951. Field studies on carbon dioxide as a possible host simulant to mosquitoes. Soc. Expt. Biol. and Med. Proc. 77(1):64–66.

SMITH-WHITE, S. 1950. A note on non-reciprocal fertility in matings between subspecies of mosquitoes. Linn. Soc. N.S. Wales Proc. 75 (5/6):279–281.

STEINIGER, F. 1950. Die malaria ubertrager Schleswig-Holsteins. Ztschr. f. Tropenmed. u. Parasit. 2(1):94–106, 23 refs.

VINCKE, I. H., AND LELEUP, N. 1950. Notes ethologiques et biologiques sur *Anopheles argenteolobatus* Gough. Soc. Belge de Med. Trop. Ann. 30(6):1605–1611.

VUKASOVIC, P. 1950. Investigations on anophelism in the region of Belgrade. Higijena 2 (5/6):507–526. [In Czechoslovakian].

WHARTON, R. H. 1950. Daytime resting places of *Anopheles maculatus* and other anophelines in Malaya, with results of precipitin tests. Med. Jour. Malaya 4(4):260–271, 20 refs.

WOODHILL, A. R. 1950. Further notes on experimental crossing within the *Aedes scutellaris* group of species (Diptera, Culicidae). Linn. Soc. N. S. Wales Proc. 75(5/6):251–253.

See also Markos under Aerial Application.

TECHNIQUE

EMILI, H. 1950. Practical method of transportation of mosquito eggs. Higijena 2(4):319–321. [In Czechoslovakian].

SCHIAVI, P. A., AND FRANCO, A. C. 1950. Nova tecnica para repasto sanguineo dos mosquitos. Arq. de Hig. e Saude Pub. 14(39/42): 57–59.

DISTRIBUTION

DURET, J. P. 1950. Contribucion al conocimineto de la distribucion geografica de los culicidos Argentinos. (Diptera-Culicidae). Rev. de la San. Mil. Argentina 49(4):363–380.

MINTER, P. C. 1950. Notes on the Culicidae of central western New South Wales following the 1950 floods. Austral. Jour. Sci. 13(2):50.

RACHOU, R. G., AND FERREIRA NETTO, J. A. 1950. Da presenca do *Anopheles (Kerteszia) bambusicolus* Komp, 1937 no estado de Santa Catarina (Brasil). Rev. Brasil, Malariol. 2(4): 303–305.

SENIOR WHITE, R. A. 1950. The distribution of the culicid tribe Anophelinae around the Caribbean Sea. Caribbean Med. Jour. 12(3/4):67–71, 23 refs.

See also Knight et al. and Someren under Taxonomy.

DISEASES

JELLIFFE, D. B. 1951. Blackwater fever in African children. Brit. Med. Jour. 4715:1117–1119, 14 refs.

MITAMURA, T., AND KITAOKA, M. 1950. Experimental transmission of poliomyelitis virus by mosquitoes in rhesus monkeys. Jap. Med. Jour. 3(3):167–171.

VAN DEN BERGHE, L., AND CHARDOME, M. 1951. An easier and more accurate diagnosis of malaria and filariasis through the use of the skin scarification smear. Amer. Jour. Trop. Med. 31(4): 411–413, 3 refs.

Encephalitis

ANONYMOUS. 1951. Murray Valley encephalitis. Med. Jour. Australia 1(14):526–527.

FINLEY, K. H., AND HOLLISTER, A. C. 1951. Western equine and St. Louis encephalomyelitis. Calif. Med. 74(4):225–229.

HURLBUT, H. S. 1951. The propagation of Japanese encephalitis virus in the mosquito by parenteral introduction and serial passage. Amer. Jour. Trop. Med. 31(4):448–451, 6 refs.

WENNER, H. A., AND COWORKERS. 1951. Encephalitis in the Missouri River Basin. II. Studies on a focal outbreak of encephalitis in North Dakota. Pub. Health Rpts. 66(34):1075–1085, 11 refs.

Filariasis

BOWIE, J. H. 1950. Filariasis. Edinburgh Med. Jour. 57(12):561–571.

BRISCOE, M. S. 1950. Notes on Bancroftian filariasis in the central province of Liberia. Natl. Med. Assoc. Jour. 42(6):384–385.

CABRERA, B. D., AND TUBANGUI, M. 1951. Studies on filariasis in the Philippines. III. *Aedes (Finlaya) poicilius* (Theobald). The mosquito intermediate host of *Wuchereria bancrofti* in the Bicol region. Acta Med. Philippina 7(3):221–229.

KERSHAW, W. E. 1950. Studies on the epidemiology of filariasis in West Africa, with special reference to the British Cameroons and the Niger Delta. I. Methods of survey for infections with *Loa loa* and *Acanthocheilonema perstans*. Ann. Trop. Med. and Parasitol. 44(4):361–378.

MALDONADO, J. F., AND COWORKERS. 1950. The role of hetrazan in the control of filariasis *bancrofti*. Puerto Rico Jour. Pub. Health and Trop. Med. 25(3):291–299.

Malaria

ANONYMOUS. 1950. Estadistica de los dispensarios antipaludicos dependientes de la Dirrecion General de Sanidad. Rev. de Sanid. e Hig. Pub. Madrid 24(9):677–692.

———— 1950. Simposio sobre paludismo. Gaceta Med. de Mexico. 80(3/4):298–378.

———— 1951. Malaria in Alabama. Med. Assoc. Alabama Jour. 20(11):453.

———— 1951. Malaria in veterans who have served in Korea. Amer. Med. Assoc. Jour. 146 (16):1523.

BALDI, A. 1950. Sul quadro anemico nell'infezione da *P. berghei* (Vincke e Lips). Riv. di Malariol. 29(6):349–356.

BELTRAN, E. 1950. Adquisiciones recientes y problemas en la parasitologia del paludismo. Gaceta Med. de Mexico 80(3/4):306–317.

BERENI, J. 1950. Trente ans la lutte antipaludique a in Salah (Tidikelt). Inst. Pasteur d'Algerie Arch. 28(4):464–468.

BULE, S. 1950. Four years of malaria control in Yugoslavia. Adrav. Radnik 5(80/81):6.

EXPERT COMMITTEE ON MALARIA. 1951. Report of the fourth session. World Health Organ. Tech. Rpt. Ser. No. 39, 30 pp.

FAUST, C. E. 1950. Un siglo de malaria en los Estados Unidos. Gaceta Med. de Mexico 80 (3/4):318–333.

FLORES ESPINOSA, J. 1950. Relato del simposio sobre paludismo. Gaceta Med. de Mexico 80 (3/4):375–378.

FRANCESCON, M., BOVO, G. 1951. Particolare forma di ritmo nodale stabile da malaria. Acta Med. Patavina 12(1):73–92.

FROLIANO DE MELO, I. 1951. A malaria, a tuberculose e a lepra em Goa. An. Paul de Med. e Cirurg. 61(1):7–16.

HAAS, W. 1950. Zur frage der provozierten malaria tertiana. Deut. Gesundhwes. 5(52):1641–1643.

HLOUCAL, L., AND NIKODEM, A. 1951. Autochthonous malaria in southern Czechoslovakia. Casopis Lek. Ces. 90(10):302–307.

LEBON, J., AND SENEVET, G. 1951. La transmission of malaria. Sem. des Hop. [Paris] 27 (18):753–755.

LEESON, H. S., AND COWORKERS. 1950. *Anopheles* and malaria in the Near East. London School Hyg. and Trop. Med. Res. Mem. 7, 223 pp., 64 refs. London.

LOZANO, A. 1950. Paludismo en Africa Ecuatorial. Rev. de Sanid. e Hig. Pub. 24(11/12): 868–880.

MOLLHAUSEN, W. 1950. Zur virulenz der griechischen malaria. Ztschr. f. Tropenmed. u. Parasit. 2(1):75–78.

———— 1950. Malaria und wasserbau in Griechenland. Ztschr. f. Tropenmed. u. Parasit. 2(1):79–82.

MORIN, H. G. 1950. Moustiquaire chimique et paludisme rural. Soc. de Path. Exot. Bul. 43 (11/12):747–753.

PINOTTI, M. 1951. Malaria e doenca de Chagas; dois grandes problemas nacionais de saude em via de solucao. Rev. Brasil. de Med. 8(1): 34–40.

QURAISHI, M. S., AHMED, M., AND GRAMICIA, G. 1951. Pre-monsoon malaria transmission in the district of Mymensingh, East Pakistan. World Health Organ. Bul. 3(3):673–682.

RAFFAELE, G., AND BALDI, A. 1950. Sulla morfologia e sulla trasmissione di *P. berghei* (Vincke e Lips). Riv. di Malariol. 29(6):341–347.

RICHTER, B. 1950. Review of post-war control of malaria and objectives for 1950. Higijena 2(4):299–311. [In Czechoslovakian]

SANI, A. 1950. L'endemia malarica del basso ferrarese dal 1940 al 1948. Ann. San Pub. [Rome] 11(4):1149–1161.

TRAGER, W. 1950. Studies on extracellular cultivation of an intracellular parasite (avian malaria). I. Development of the organisms in erythrocyte extracts, and the favoring effect of adenosenetriphosphate. Jour. Expt. Med. 92(4): 349–366.

WILCOX, A. 1950. Manual for the microscopical diagnosis of malaria in man. (Second Edition). Natl. Inst. Health Bul. 180 (Revised) 49 pp. 64 refs.

Malaria—Clinical Aspects

CHAKRAVARTI, H. 1950. Studies on plasma protein. III. Malaria. Indian Med. Gaz. 85(11): 500–503.

COTINI, M., AND STEFANACCI, G. 1951. Sulle psicosi malariche. Rass. Stud. Psichiat. 40(1):1–26.

DARBON, A., SOCHIER, R., AND RAYMOND, M. 1950. Nouvelle reaction serologique du paludisme a l'hemozoine artificielle de Henry. Ann. Biol. Clin. 8(4):466–470.

DRUKKER, W., AND VRIES, S. I., DE. 1950. Entmalaria door bloedtransfusie. Nederland. Tijdschr. v. Geneesk. 94(46):3312–3315.

FUHRMANN, G., AND KNUTTGEN, H. 1950. Serumeisenbefunde bei malaria tertiana. Ztschr. f. Tropenmed. u. Parasit. 1(4):515–526, 17 refs.

GUPTA, P. N. 1951. Malaria menace. II. (How we suffer). Antiseptic 48(3):184–185.

LINDSKIS, D. I. 1950. Malaria urticaria. Sovet. Med. No. 11:34.

LIPPI, M. 1950. La funzionalita renale nei malarici cronci. Arch. Ital. Sci. Med. Trop. e Parassit. 31(6):407–421, 43 refs.

LO, W. B. 1950. Neuromyelitis optica associated with malaria. Chinese Med. Jour. 68 (9/10):266–270.

LOPEZ RONDAL, M. 1951. Paludismo en la infancia. Arch. Pediat. del Uruguay 22(1):54.

MEYERS, F. M. 1950. Chronische malaria bekeken uit het gezichtspunt van hypersplenie. Nederland. vor Geneesk. 94(41):3006–3009.

MORETTI, G. F. 1950. Acces pernicieux algide et choc medical. Jour. Med. Bordeaux 127(10): 676–685.

———— 1951. L'acces pernicieus palustre et son traitement. Presse Med. 59(14):313.

NOYAN, A. 1951. Die klinischen formen der malaria in der Turkei. Ztschr. f. Tropenmed. u. Parasit. 2(4):491–497.

PIZZILLO, G. 1950. Sindromi addominali acute da malaria (pseudo-colecistite—pseudo-appendicite). Riv. di malariol. 29(5):315–320, 15 refs.

SALMANOFF, A. 1951. Le paludisme chronique. Vie Med. [Paris] 32(4):73–74.

SHRIVASTAVA, N. P. 1951. A case of cerebral malaria. Antiseptic 48(4):301–302.

UEBEL, H. 1950. Malaria in Macedonia after the war from the pathological aspect. Ztschr. f. Tropenmed. u. Parasit. 2(2):239–245, 16 refs. [In German].

Malaria—Epidemiology

HUGUNOT, R. 1950. Une epidemie de paludisme au Sahara. Inst. Pasteur d'Algerie. Arch. 28(4):469–508.

MARTINEZ BAEZ, M. 1950. Algunos aspectos epidemiologicos del paludismo. Gaceta Med. de Mexico 80(3/4):298–305.

RICO-AVELLO Y RICO, C. 1950. La epidemia de paludismo de la postguerra. Rev. de Sanid. e Hig. Pub. 24(10):701–737.

RUSSELL, P. F. 1951. Some epidemiological aspects of malaria control with reference to DDT. Natl. Malaria Soc. Jour. 10(3):257–265, 33 refs.

VAN DER KUYP, E. 1950. Contribution to the study of the malarial epidemiology in Surinam. Meded. 89, Afdl. Trop. Hyg. No. 18, 146 pp., 132 refs.

Malaria—Plasmodia

ADLER, S., YOELI, M., AND ZUCKERMAN, A. 1950. Behavior of *Plasmodium berghei* in some rodents. Nature [London] 166(4222):571.

ASCOLI, M., AND D'ALESSANDRO, G. 1950. Some remarks on the life cycle of the malaria parasite in the human host. Acta Tropica 7(4): 367–371.

BRUCE-CHWATT, L. J. 1951. Gametocyte rates. Roy. Soc. Trop. Med. and Hyg. Trans. 44(6):761–763.

CAVACEPPI, L. 1951. Durata del ciclo endoistiocitario del *Plasmodium gallinaceum* determinata mediante ripetute biopsie di corteccia cerebrale. Riv. di Parassitol. 12(3):163–168.

CORRADETTI, A., AND VEROLINI, F. 1951. Relazioni tra *Plasmodium berghei* e cellule della serie Rossa durante l'attacco primario nel ratto albino. Riv. di Parassitol. 12(2):69–84.

EYLES, D. E. 1951. Studies on *Plasmodium gallinaceum*. I. Characteristics of the infection in

the mosquito, *Aedes aegypti*. Amer. Jour. Hyg. 54(1):101–112, 10 refs.

GALLIARD, H., AND LAPIERRE, J. 1950. Recherches sur le initial de *Plasmodium berghei*. Soc. de Path. Exot. 43(7/8):410–412.

HAWKING, F., AND THURSTON, J. P. 1951. A strain of monkey malaria *(Plasmodium cynomolgi)* made resistant to proguanil (paludrine). Roy. Soc. Trop. Med. & Hyg. Trans. 44(6):695–701, 16 refs.

HUNNINEN, A. V. 1951. Comparative susceptibility of four anopheline mosquitoes to *Plasmodium relictum*. Natl. Malaria Soc. Jour. 10 (3):217–223, 4 refs.

LAVIER, G. 1950. Il ciclo evolutivo dei parasiti della malaria. Riv. di Malariol. 29(6):370–372. Also in Therapie [Paris] 5(6):280–281.

MCFADZEAN, J. A. 1951. Morphological changes in *Plasmodium cynomolgi* following proguanil, sulphadiazine, and mecaprine therapy. Roy. Soc. Trop. Med. and Hyg. Trans. 44(6):707–716, 7 refs.

MUDROW-REICHENOW, L. 1951. Uber die chemotherapeutische beeinflussbarkeit des *Plasmodium berghei* Vincke et Lips. Ztschr. f. Tropenmed. u. Parasit. 2(4):471–485.

THURSTON, J. P. 1951. Morphological changes in *Plasmodium berghei* following proguanil, sulphadiazine and mecaprine therapy. Roy. Soc. Trop. Med. and Hyg. Trans. 44(6):703–706, 2 refs.

VINCKE, I. H., AND LIPS, M. 1951. Note sur la transmission cyclique du *Plasmodium berghei*. Soc. Belge de Med. Trop. Ann. 30(6):1601–1603.

Malaria—Therapeutics and Antimalarials

ANONYMOUS. 1950. Estadistica de los dispensarios antipaludicos dependientes de la Direccion General de sanidad. Rev. de Sanid. e Hig. Pub. 24(10):775–785.

———— 1951. Chloroquine (SN-7618-5) or aralen (SN(7618)(W-7618) and paludrine used as mass suppressive treatment for malaria in three Gatun Lake villages—a year's observation on results of voluntary use. Ann. Rpt. Gorgas Mem. Lab., 1950, pp. 26–27.

———— 1951. Controverse sur le traitement du paludisme. Vie Med. [Paris] 32(1):55–58.

———— 1951. Experience in malaria control by the use of drugs and DDT. Ann. Rpt. Gorgas Mem. Lab., 1950, pp. 24–25.

ALVING, A. S. 1950. A review of the best new antimalarial drugs. What's New 151:8–9.

BAILLET, J. 1950. Traitement curatif du paludisme. France Med. 13(12):41.

BENITEZ CALVO, L. A. 1951. Como podemos comprobar la eficacia de un medicamento antipaludico. Medicina Colonial 17(1):40–53.

BONNIN, H. 1950. Che cosa pensare della chinina. Riv. di Malariol. 29(6):375–376. Also in Therapie [Paris] 5(6):283–285.

BRODIE, B. B., AND UNDENFRIEND, S. 1950. Metabolites of pamaquine in urine. Soc. Expt. Biol. and Med. Proc. 74(4):845–848, 10 refs.

BRUCE-CHWATT, L. J. 1951. Evaluation of synthetic anti-malarial drugs in children from a hyperendemic area in West Africa. Roy. Soc. Trop. Med. and Hyg. 44(5):563–592, 36 refs.

DECOURT, P. 1950. La terapeutica contro le recidive malariche. Riv. di Malariol. 29(6):373–375. Also in Therapie [Paris] 5(6):281–283.

DE LUCENA, D. T. 1950. Tratamento da malaria pelo camoquin. Rev. Brasil. de Med. 7(9): 588–592.

DE MAGISTRIS, L. 1950. Contributo clinico alla cura della malaria con il metodo di ascoli. Progresso Med. Napoli 6(23):771–775.

ECKERT, D., PAASONEN, M., AND VARTIAINEN, A. 1951. On histamine in the gnat *(Culex pipiens.)* Acta Pharmacol. et Tox. 7(1):16–22.

EFFIMOF, M. 1950. A malaria e sen tratamento pelo jejum; o meu proprio caso. Rev. Brasil. Med. 7(11):743–745.

EVERARD NAPIER, L. 1951. The treatment of malaria. Med. Press, London 225(10):229–232.

GEUKENS, A. 1950. Proefnemingen met paludrine. Soc. Belge de Med. Trop. Ann. 30(3): 429–440.

HULSHOFF, A. A. 1951. Behandeling van malaria tertiana met nivaquine-plasmochine. Nederland. Tijdschr. v. Geneesk. 95(10):820–823.

JANSSENS, P. G., VERSTRAETE, N., AND SIENIAWSKI, J. 1950. Essais de chimioprophylaxie antipaludique collective chez les enfants des travailleurs des mines de Kilo. Soc. Belge de Med. Trop. Ann. 30(3):449–478. [A continuation of article in ibid. 30(2):257–286.]

LEBON, J., AND FABREGOULE, M. 1951. Le traitement du paludisme aigu. Sem. des Hop. [Paris] 27(18):755–761.

———— 1951. Le traitement du paludisme chronique. Sem. des Hop. [Paris] 27(18):761–765.

LEBON, J., AND SENEVET, G. 1951. La prophylaxie du paludisme. Sem. des Hop. [Paris] 27(18):765–768.

MACLEOD, R. C. 1951. Prophylactic proguanil in the southern highlands of Tanganyika. Brit. Med. Jour. 4701:282.

MUKHERJEE, S. 1951. The present status of anti-malarial drugs and the future of cinchona in India. Indian Med. Assoc. Jour. 20(4):137–140.

PAULSHOCK, M., AND MOSER, C. M. 1950. Naphthoquinone antimalarials. XXV. Naphthoquinones with oxygen in the side chain. Amer. Chem. Soc. Jour. 72(11):5073–5077.

PICAZO GUILLEN, J. 1950. Estudios sobre paludismo. II. Profilaxis e inmunidad. Medicina [Madrid] 18(2/3):217–224.

PIZZILLO, G. 1951. L'impiego della chininaetiluretano per via endovenosa nelle fasi febbrali dell'infezione malarica; storia, pregiudizi, azione benefica della chinina. Riv. di Malariol 30(1): 1–15.

POINDEXTER, H. A. 1951. A study of the prophylactic value of chloroquine in children. Jour. Pediat. 38(2):169–171.

RAFFAELE, G. 1950. Il trattamento dell'attaco malarico acuto. Riv. di Malariol. 29(6):357–370.

RUGE, H. 1950. Die malaria am westlichen schwarzen meer und ihre Beeinflussung durch schutzbehandlung mit atebrin. Ztschr. f. Tropenmed. u. Parasit. 2(1):83–94, 23 refs.

SINTON, J. A. 1950. Protezione chemioterapica individuale e collettiva contro la malaria. Riv. di Malariol. 29(6):377.

SOBERON Y PARRA, G. 1950. Terapeutica del paludismo. Gaceta Med. de Mexico 80(3/4):334–351.

SOKAL, J. E. 1950. Treatment of intolerance to quinacrine. U. S. Armed Forces Med. Jour. 1(10):1167–1170.

TAREEV, E. M. 1951. Modern methods in the treatment of malaria. Sovet. Med. 3:8–10.

THURSTON, J. P. 1950. Action of proguanil on *P. berghei*. Inhibition by *p*-amino benzoic acid. Lancet #6631:438.

VAN RIEL, J. 1950. Chemioterapia degli antimalarici sintetici. Riv. di. Malariol. 29(6):372–373.

WALLACE, R. B. 1951. Malaria control on estates. Planter 27(1):16–25.

ZSCHUCKE, J. 1951. Zur frage der viruleny der griechischen malaria und der wirksamkeit der verschiedenen verfahren der atebrinprophylaxe. Ztschr. f. Tropenmed. u. Parasit. 2(4):485–491.

Yellow Fever

ANONYMOUS. 1951. Fiebre amarilla selvatica en Bolivia. Bol. de la Ofic. San. Panamer. 30(3): 341–342.

BEJARANO, J. F. 1951. Nota previa sobre la existencia de fiebre amarilla trasmitida por culicidos no domesticus en la Republica Argentina. Dia Med. [Buenos Aires] 23(11):435–441.

HAHN, R. G. 1951. A combined yellow fever-smallpox vaccine for cutaneous application. Amer. Jour. Hyg. 54(1):50–70, 28 refs.

LACORTE, J. G. 1950. Virus pantropicos. V. O. virus da febre amarela. Rev. Brasileira Med. 7(9):593–600.

LOPEZ SANCHEZ, J. 1951. Tomas Romay and the yellow fever. Jour. Hist. Med. and Allied Sci. 6(2):195–208.

RODANICHE, E. DE. 1951. Studies of virus and rickettsial diseases. Ann. Rpt. Gorgas Mem. Lab., 1950, pp. 10–12.

MISCELLANEOUS

BROWN, A. W. A. 1951. Insect control by chemicals. 817 pp. London, Ontario.

SCHENK, P. J. 1950. Mosquitoes; troublesome and sometimes dangerous pests. Cult. en Handel 16(9):553–554.

SHEPHARD, H. H. 1951. The chemistry and action of insecticides, 504 pp. New York.

SOLODOVNIKOVA, O. I. 1950. Developmental cycle of the fat body and its connection with fertility in mosquitoes, *Anopheles maculipennis sacharovi, A. superpictus,* and *A. hyrcanus.* (In Russian.) Zool. Zhur. 29(6):545–555.

Did you read the announcement of the AMCA 1952 meeting in Salt Lake City in March? See page 224.

The *Notice of Publication* on Page V is important. Watch for the *Bulletin.*